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ABIES SPECTABILIS SPACH AND A. PINDROW SPACH

BY R. N. PARKER.

In the *Indian Forester*, Volume LIII (1927), pages 683 to 693, I gave an account of the two Western Himalayan Silver Firs and as I have since then had several opportunities of seeing these trees again, I should like to add some further notes on them. I have since come to the conclusion that these two species hybridise rather freely and that in consequence a sharp distinction between them is not always possible. In places where they are separated by an interval of some 500 to 1,000 feet, there is little difficulty in distinguishing the two but sometimes this intermediate zone contains a few stray trees which show intermediate characters and are almost certainly hybrids. Sometimes there is no intermediate zone at all and as one ascends in the fir forests one comes across occasional trees suggestive of *Abies spectabilis* rather than *A. pindrow*. In such cases I have been doubtful whether there is any pure *Abies spectabilis* at all as the trees seem to be all *A. pindrow* or hybrids. As *A. pindrow* is more abundant than *A. spectabilis*, the latter appears to become submerged, leaving only *A. pindrow* and hybrids. It is possible that the reverse may occur and that a small proportion of *A. pindrow* might become lost in a mass of *A. spectabilis*, leaving only pure *A. spectabilis* and hybrids, but I have not observed this. Failure to realise that hybrids frequently occur has made my remarks on the unreliability of supposed anatomical differences valueless. This question needs further investigation with material collected from trees in which hybridisation is unlikely.

The two species can be distinguished in the field by habit. Middle-aged trees of *A. spectabilis* have the branches more widely spreading than those of *A. pindrow* and consequently the crown

is not so conical. In older trees of *A. spectabilis* the tips of the branches are upcurved which together with the slightly broader crown distinguishes it from *A. pindrow*. In very old trees the original crown disappears and is replaced by short branches which arise from the main stem. This gives the old trees a very narrow crown, much narrower than the crown of *A. pindrow*, and when some of the original branches remain, a very ragged appearance results.

The accompanying photograph shows an old specimen of *A. spectabilis* at about 11,000 feet near the top of the Haranghati Pass in Bashahr. In the upper part the original crown has gone though a few dead branches are still left. The characteristic up-curving of the tips of the branches can be seen in the lower part of the tree. I have not been able to ascertain the reasons for the tendency for old trees to lose their original crowns. Snow-break may have something to do with it but as dead, leafless, branches are often seen projecting well beyond the secondary crown, snow cannot be entirely responsible. As growth is slow at elevations of 11,000 feet, amounting to about four inches in height per annum or even less, occasional damage by hail or squirrels or insects may easily cause the death of branches of old trees. I have seen short, leafy twigs lying on the ground in considerable numbers under old trees and suspect that hail may have been responsible for bringing them down.

As regards the recognition of suspected hybrids amongst trees, mainly *A. pindrow*, the first thing to look for is the up-curved tips of the branches. Trees which show this character usually show the hairy shoots of *A. spectabilis* but they do not always do so. In some places there appears to be a polymorphic population showing the characters of *A. spectabilis* and *A. pindrow* in various combinations. This appears to be exactly comparable with the intergrading of *Abies alba* and *A. cephalonica* in S. E. Europe, referred to by Turrill in "A Contribution to the Botany of the Athos Peninsula," Kew Bull. Misc. Inf. 1937, pp. 270-271. This has also been suggested as due to hybridisation and Turrill puts forward another possible explanation that

it might be due to an earlier evolutionary condition from which *A. alba* separated northwards and *A. cephalonica* southwards through loss of different genes.

Turrill's suggestion does not appeal to me as likely in the case of *Abies spectabilis* and *A. pindrow* as it involves the supposition that a new species is being evolved in a number of more or less isolated localities. It seems to me more likely that before the ice age there were two distinct silver firs in the N. W. Himalaya and that during the ice age they were forced to migrate. If the changes in climate were sufficiently rapid one species would invade the zone of the other and hybridising would result in a mixed population with perhaps the more or less complete submergence locally of one or other species. What is now occurring may be the separation of the hybrid population into two species similar to the originals. This would explain the somewhat haphazard occurrence of *A. spectabilis* as it is only necessary to suppose that when driven down into the zone of *A. pindrow* it became locally completely submerged and has not been able to separate out again. As the interval between the two species where they are distinctly separated is only 500 to 1,000 feet no very great or rapid change of climate would be needed to cause the two species to mingle.

A FLYING VISIT TO EAST AFRICA

By H. G. Champion.

First let me explain that we did not fly to, in, or from East Africa, much as we should have liked to, but it was our time that flew and flew at record speed. After repeated scrutiny of the overdraft, minimising its significance in every possible way, we decided that the increase resulting from the projected trip would not render it too terribly overwhelming, and that, anyway, it is very sound to materialise such delightful castles in the air as soon as possible, because one may not get another chance, or one may get too old to want to materialise them. So we wrote to good friends out there, some of whom we had had the pleasure

of meeting in India, with due mention of the necessity of treating the overdraft tenderly and asking what about it. Plans were drawn up and we left Bombay on May 10th for Mombasa, after a joyful afternoon's sail and morning's sea bathing.

We met with disappointment at the Seychelles having greatly looked forward to seeing something of these very interesting islands: one of the stokers had developed measles, and as he might have contacted a seaman, who might have contacted a steward, who might have contacted one of us, and as, moreover, the Seychelles are very, very sensitive to measles, we were all put in quarantine, and had to try to be content with a bathe, admittedly delightful, under the coconuts of Quarantine Island, the compulsory home for a fortnight of those who had to land.

At Mombasa, one of the most pleasant and unspoiled harbours I have seen, we at once sampled the unstinted hospitality extended to us everywhere we went: comfortable quarters had been arranged at the Club, and plans were soon being further developed over a drink. Incidently, Mombasa was unbelievably cool, fans being unnecessary and as good as non-existent.

Reports from Tanganyika warned us that the rains were still on and roads liable to be impassable: we had better limit our tour there to Kilimanjaro, and a trip by rail to the Agricultural Research Station at Amani, and give up the previous plan of going down to Dar-es-Salaam, and visiting the Southern Highlands where we had a cordial invitation to come and see how perfect they were for settling with a pension from India.

A day or two was down for seeing something of the Coast Division of Kenya centring on Mombasa. The mangrove forest is of importance for fuel and small timber, but we had no time for this and were unable to do more than visit a few of the more accessible corners of the forests which are still in the process of demarcation and reservation. The valuable timber tree here is the composite *Brachylæna* and we saw underplanting experiments in inferior forest with *Chlorophora*, of which more anon. Of botanical interest were the fine fruiting and flowering specimens of the *Cycad*, *Encephalartos*, and—somehow unexpectedly, our familiar

scrambling lily, *Gloriosa*—and, of course, the picturesque baobabs. Misfortune overtook us on the way back next morning for the car got bogged four times in succession in a short length of road which we had negotiated without difficulty when outward bound. Our train up-country left at 4-15 and we arrived for it at 6-30. Now trains in East Africa mostly run but twice a week and this mishap deprived us of a third of the allotted time in Tanganyika and limited us to the Kilimanjaro neighbourhood. However, there was certainly no question of the time hanging on our hands, with sea-bathing and sailing available.

Kilimanjaro is a grand mountain, a gigantic extinct volcano, 19,000 feet, comparable with Fujiyama, though admittedly not quite so beautiful. Roads and weather were still not as good as one could have wished, but still good in parts and nowhere impossibly bad. We had two delightful trips, one up the south side and another, after a 70-mile drive round the mountain, up the north side with the D. F. O. Had we known all about it beforehand, we should have gone to the top with a guide as it can be done in 5 days' 'safari,' or at least have crossed the saddle at about 13,000 feet which we approached from the two sides. The climb is expensive but worth it: one makes use of Alpine huts at about 10,000, 13,000 and 16,000 feet, and African porters only carry a miserable load compared with our *paharis.* None of the higher forests on the mountain are being worked, but demarcation and reservation were most important as the tree cover was being destroyed at a very rapid rate We met the African Pencilwood Cedar, *Juniperus procera,* magnificent specimens even if spongy with *Fomes,* and both species of *Podocarpus, P. melanjianus* and *P. gracilior,* for the first time, but perhaps the most interesting botanical thrill was to walk under the heather instead of through it, for the heath here, though for all practical purposes exactly like our old friend *Calluna,* are 30 to 40 feet high, sometimes mixed with small-leaved *Hypericum* of similar size. The grass-lands at 10,000 to 11,000 feet on the southern side were delightful and full of flowers, including orange *Gladiolus* and *Tritoma, Anemone, Scabiosa,* and a host of other familiar genera. Incidentally, there is curiously enough no bamboo on Kilimanjaro.

It was on the northern side that one of us got the first excitement from the fauna. Having climbed for several hours, we reclined on an aromatic bed of *Artemisia*, etc., in a glade in the tree heath. The men couldn't resist the usual urge to climb a bit further before turning back; my wife could and did suppress it and stayed put. Somnolently opening one eye, what should be imaged on it but a cow rhino trotting up with her calf at heel. Luckily, they were up the wind and, passing a few yards away, they cluttered across the brook where we had just been washing up, and so out of sight. Unfortunately, the tiffin boy wouldn't confirm the tale, but he was charged with being asleep, and we had to accept it as true—footprints were a bit vague, but there certainly were rhino and eland about.

We then made the rail journey round to Nairobi, and in the last three hours began to understand how visitors so usually come back with animal photos. The animals really are there in herds and flocks all over the grass-land and low thorn savanna taking no notice of trains and cars. There are all the zebra wildebeest (gnu), hartebeest, antelope (mostly Thomson's or the more familiar "tommies") and ostrich one could ask to see, and, here and there, what we wanted most to see, the odd giraffe. An afternoon outing by car with our host across the plains to the edge of the famous Rift-Valley gave us further opportunities of seeing the game and added two fine birds, the big florican and the strange ground hornbill.

Time did not permit of any delay in the metropolis, and, after a drive round and a walk in the 80-acre arboretum in which the Conservator's house stands, we were off again by car, with a full programme of inspection of nurseries and plantations, mostly gums and cypress, to Kinancop Forest Station, at about 9,000 feet. I do not propose to describe these forest activities in detail, and will content myself with mentioning that the standard of work is very definitely beyond that usually met with in India; the reasons for this are not difficult to trace, and it is possible to justify our preference for direct sowing and natural regeneration, but the fact remains. Rest-houses in East Africa are not quite what we are used to in India and would probably mostly be termed "huts" by us.

but they serve their purpose, and, it is to be remembered, it has taken us some 70 years to reach our present position in this matter: Kinancop was formerly a forester's headquarters and is a furnished two-storied wooden building. The memory of our walk over the Aberdares, camping at the edge of the moorland and climbing the 12,816-foot peak will long remain with us as one of the high spots in both senses of the whole trip; delightful hill country, marvellous views, novelty in bird, beast and plant, the best of company (we were at the junction of two divisions and both D. F. O.'s were with us) all combined to make it so. Here we got among the famous tree Senicios and high-level tree Lobelias; we fished for and caught trout; we walked for miles over the moors and through the mountain bamboo brakes; we got shots at, but did not get, the big francolins; and if we did not meet the elephant and rhino that frequent the hills, at least they had left all the necessary indications they had been on the track a brief hour or so before us.

This walk took us to Nyeri, where the wealthy go to stay in the Tree Top Hotel to see rhino and elephant. We went trout fishing instead, and had grand sport under the skilled directions of our host. We also saw something of the "camphor" forest (*Ocotea usambarensis*) and milling and interesting plantations of various species, including species of *Cordia*, *Vitex* and *Macaranga*, though cypress and *Grevillea* predominate.

From Nyeri, we were passed on to Thomson's Falls Division in the cedar country visiting, *en route*, one of the most delightful gardens I have seen anywhere. It had been created in three seasons from a few acres of more or less xerophytic scrub with a few picturesque residual trees, by great skill and artistic ability, utilising the old trees, some good springs, good turf-forming grasses and the wonderful climate, and an exceptionally big range of flowering herbs and shrubs. We shared our lunch with a funny old hornbill and some very graceful crested cranes and didn't want to leave. However, we were rewarded for our strength of mind in getting away not more than an hour late by having just time to catch half a dozen rainbow trout before dark in the shady Narok below the Falls. The next day in seeing over a mill sawing the cedar, I discovered the reason—it was *Fomes*—for the unbelievable

figure of 80 per cent. the D. F. O. had given me for deduction made on quarter-girth measurements in calculating royalty due from the lessee.

The time allotted to Kenya being up, we were railed off to Uganda, the journey including a night on the *Papyrus*-fringed Lake Kioga, really part of the Victoria Nile, and a longish bus ride across to Lake Albert. Here we boarded a steamer for a trip to the famous Murchison Falls in the Victoria Nile, the Conservator and his wife taking a couple of days' leave to join us. This trip is made as much to see the fauna as the falls, if not more so, and the said fauna played up perfectly. One is afraid of exaggerating, but we can't have seen less than five hundred hippo and 300 crocodile. I counted 70 hippo simultaneously in sight several times and the crocodile lay literally in heaps—50 at a count frequently. But more thrilling still were the elephant, despite their smaller numbers. Coming quietly round a corner in the sternwheeler, we came across a couple on a small grassy island well away from the bank and all available films on all the cameras were used up before they waded out of range. It was perhaps as well we didn't stumble on them during our walk to the top of the falls (preceded by an armed game scout and followed up by two spearmen—disguised boatmen), but they had only just moved off when we arrived; hippo and crocodile we passed at 20-and 30-yard ranges. We did better still with the elephant going down again, for we surprised one half-way across the stream and were able to manœuvre as close as our skipper cared to take us.

The next two days were spent in one of the most interesting forests of East Africa, Budongo, where the "mahoganies" *Kayea* and *Entandophragna*, as well as several other forest giants, are being worked out, and combined artificial and natural regeneration work done in the felled-over areas. The trees we saw being felled and the logs obtained could only be paralleled by our best gurjan. Meanwhile, my wife sampled the Lake Edward fishing, and the two rods, in a few hours, had landed ten Nile Perch including fish of 84, 34 and 19 pounds with a fearsome tiger fish of eight pounds as make-weight.

Next followed a long motoring tour taking us through the greater part of Uganda, past craters and soda lakes, gold-mines and tin-mines, high country including the very pleasant Kabale District in the south-west on the Congo border, and low country. Grassy thorn scrub and *Papyrus* swamp are the most prevalent types of vegetation, the former much influenced by the prevalent burning, which is a complicated proposition involving tsetse control, grazing requirements and sheer indifference to its direct and indirect results. The *Papyrus* swamp appears to build up a rich soil capable of drainage and very successful afforestation with the *Eucalyptus robusta*, judging from the results seen near Kampala but the ultimate effects which might follow extensive drainage and cultivation on climate and water supplies provide material for speculation. More densely settled tracts feel acutely the shortage of fuel and poles for hut building, and every encouragement is given to the people to raise small plantations of gums, wattle, etc., to meet their own requirements. Success evidently depends primarily on the drive supplied by the local administrative officers, but an appreciable measure of success has been obtained in some districts.

In the eastern parts of Uganda, from car or train, one's attention is attracted by a shapely umbrageous tree frequent among cultivation: this is *mvule* or *Chlorophora excelsa* which enthusiasts would have one believe leaves teak standing as the perfect general utility timber. Be that as it may, *mvule* is obviously a species to be encouraged and is being planted a good deal. It suffers from a crippling gall if put out in the open, but seems capable of getting up through a good deal of shade and so is mostly being underplanted in second growth high forest and gum plantations. It should be worth a trial in India. Incidentally, Indian trees have been very freely introduced in East Africa including *Cedrela toona* and *Melia azedirach*; both grow too fast and with bad shape, the latter to an absurd degree, the branches being positively serpentine, unable to support their own weight. Teak has been tried with poor results.

The last special entertainment was barbel fishing in the Victoria Nile at the foot of the Ripon Falls where it leaves the

Victoria Nyanza. Our host promised us a fish per 15 minutes, nothing under four pounds. We landed a fish per 15 minutes, except that the last, a 14-pound one, hooked well inside the time-limit, took 55 minutes to land. This was at Jinja, where the hippo grunted under the hotel windows. After this, we had only a final drive to the Kenya border again at Tororo, and on the lower slopes of the other big peak Mount Kenya, before we had to rail down past Lake Nakuru with its myriads of flamingo, and Nairobi, with a last look at the big game, back to Mombasa again. We left with the feeling that despite a good deal of travelling elsewhere, we had never had a better five weeks' trip, and the hope that we shall, in the not-too-distant future, be able to return some of the cordial hospitality shown to us all along the line.

East Africa has a big future before it. That the forest departments can be counted on to fill no minor rôle in that development is shown by what they have already accomplished. We recommend a visit to any Indian forester who has the time. It may be noted that the governments are generous to the official visitor, taking him at half rates anywhere on the railways. The detour from the journey between India and Europe is not very great or costly, and living is no more expensive than elsewhere, so that the extra cost is not unreasonable.

THE SOIL CATENA

By M. V. Edwards.

Summary.—The origin of the term soil catena is explained with an example.

A brief description of the topography and resulting soil catenas of the Pegu Yoma in Burma is given.

The way in which the vegetation follows the soil catena is described and the use which is and might be made of these variations in the management of the forests is noted.

The term "soil catena," which was introduced into the *Indian Forester* of September, 1939, may be a new term to readers, but the arrangement of soil types that it describes is familiar to many even if not recognised by that name. An explanation of the term and some details as to its practical application may therefore be of interest.

The term "catena" (Latin, "a chain") was introduced by G. Milne of the East African Agricultural Research Station at Amani, and was first described in "Soil Research" for 1935, the journal of the International Society of Soil Science. It is used to describe a distribution of soil types dependent mainly on the topography, as in the following example, which is from Uganda.

A—On the hill-tops.—Greyish-black, shallow soil not more than two feet thick, passing through a layer of quartz fragments to a thick bed of rotting rock. In some districts but not others a thick stratum of "murram" (*laterite*) overlies the rotten rock.

B—On the slopes.—Red soil many feet in thickness, not laterised, or of incipient laterisation only.

C—On the fringe of the swamps.—Grey, sandy soil with red and yellow mottling at four feet depth.

D—The swamp soils.—Intensely black top-soil overlying grey or bluish water-logged clay, acid and devoid of calcium carbonate.

It may be noticed in passing that there are soils in Burma somewhat resembling this Uganda soil described by Milne.

This arrangement of soils is found repeated ridge after ridge and hollow after hollow, and a cross-sectional elevation of their profiles would resemble the hanging loops of a chain suspended at intervals.

When a regular pattern of soils of this nature is found to exist, description and mapping are very much facilitated. A description of one complete "loop" can be made in great detail and the description can then be extended to the whole area covered by this sequence of soils on the basis of the topographic map. On this map the *catena* is usually shown by vertical strips regularly arranged, using the colours that stand for the various types found in the *catena*. More detail can be indicated by making the width of the strips proportionate to the average extent of the soils on the ground.

The soils of the Pegu Yoma, the chief teak-bearing forest tract of Burma, offer in many places a very clear example of a catena.

The topography is usually rugged, and though ridges are not usually very high in relation to the streams that drain them, the country resembles a complicated pinnate leaf; the streams, represented by the midribs of leaf and pinnæ, having a considerable fall, in gullies; and the ridges, represented by the adjacent margins of the pinnæ, being narrow, though often fairly level in the direction of their length. The only flat land of any width is usually in stream loops or at stream confluences. Erosion is heavy for at least four months of the year under nearly continuous rainfall. Soil is washed off the ridges, so that it is shallow and compacted there, and accumulates where possible towards the bases of the slopes. Thus a regular catena of types on ridge top, slope and slope foot develops.

Sometimes the catena develops on sandy soils, sometimes on clayey soils, and two kinds of catena can then be distinguished. But very often the Peguan series of rocks of which the Yoma is composed consists of rapidly alternating thin bands of sandstone and clay-forming shale, and then the soil varies similarly, in spite of the variation in the general form of the catena remaining unchanged. It is usually impossible to indicate the texture variations on the four-inch scale map, when compartment descriptions are being compiled, but the general form of the catena is easily recorded. Owing to the erosion, soils have little time to develop and the profiles are mainly immature. The chief difference between types on ridge tops, slopes and at the slope bases is in the depth of the soil over the underlying rock, and also in the moisture content of the soils in the dry season, since those in the lower sites keep moist longer, owing to subterranean drainage from higher elevations.

To obtain more detail a much more elaborate form of soil survey is required, and it is mapping of this nature which is described in the *Indian Forester* of September, 1939. The plan at page 560 does not show the whole set of catenas, as Catenas 2 and 3 are only partly indicated, but it is to be supposed that they are repeated on the limestone shale and dolomite lime stone further along the line. In the case of Catena 1, the presence of Soil Types A, B and H on the valleys and Types E, F and G on the ridges is clearly shown. If the extension of the line further indicates that the same soils

occur in the same way on these geological formations, then the catena can be safely applied to the geological map according to the topography. Further detailed mapping is unnecessary. In this case there is a separate catena on each geological formation.

In the Pegu Yoma soil catenas are so obvious that little or no detailed survey is necessary. Moreover the soils are well indicated by the flora; not, as in Finland, by the herbaceous flora; nor, owing to the large number of species present, by the tree flora (except in a general way); but by the bamboo flora. Here, unlike England where human interference has drastically altered things, use of flora as a site indicator is possible. Even *taungya*-cutting does not seem to make much difference unless repeated several times, when of course its effect is serious. In the forest the way in which the vegetation follows the soil catena is very obvious, varying from dry upper mixed deciduous forest through moist upper mixed deciduous forest down to evergreen if the difference between ridge and gully is large, or only from a scanty poor quality form of moist upper mixed deciduous forest on ridge-tops to a luxuriant good quality forest of the same type, perhaps verging on evergreen, on the lower slopes. This variation may repeat itself over ridge and hollow several times in the course of half a mile, if measured across the drainage and not along it.

In so far as soil conditions determine the methods of management, the broad geological distinctions between clay soils and sandy soils, where these are extensive, are of primary importance, but when, as is usually the case, the clays and sands are much mixed up, the differences cannot be taken into account. Management in the Yoma is not yet on a sufficiently extensive scale to take them into account and so far areas of several hundred acres are the smallest that have been delimited for special treatment. In spite of these difficulties in these areas of changing soils and also in the areas of extensive clay or sand in their separate types, the difference between ridges and slopes according to the soil catena must in future be regarded as a matter of considerable importance. Where in the past it has not been so regarded, plantations have at times been made up hill and down dale, with regrettable results on the hills, but where it has been so regarded the species planted are

varied accordingly when making plantations. The time will probably soon arrive when a still further distinction is made and in certain sites plantations are confined to lower slopes and natural systems of regeneration used on ridges. Thus in Burma the principle of the soil catena is well understood, even though it is not yet referred to by that name.

ON THE DESIRABILITY OF CULTIVATING FODDER-YIELDING TREES IN THE CENTRAL PROVINCES

By K. P. Sagreiya

Pruning or lopping of trees for fodder is not permitted in the reserved forests, primarily because such "lop and top" retards the growth of trees which adversely effects the yield of timber. But the reason why there has not been a persistent demand for lopped fodder is probably the fact that like grass-cutting this will be comparatively more expensive than grazing, for which at present the people are required to pay next to nothing. The fact that this grazing is of the poorest quality, however, does not seem to worry the cattle owners.

Trees on private lands, however, are frequently lopped for fodder chiefly for goats and sheep and for elephants. The former can eat even thorny species, such as *Acacia arabica*, *A. leucophloca*, *Zizyphus* spp., etc., and the latter relish succulent twigs which constitute the main bulk of fodder lopped for elephants, though it also includes leaves. Species with thick bark (phlœm) and softwoods like *Ficus religiosa*, *Lannea grandis*, etc., and young bamboos are, therefore, preferred. The common C. P. trees that are believed to give good fodder for cattle are *Acacia arabica*, *Anogeissus pendula*, *Madhuca latifolia*, *Bauhinia malabarica*, *B. variegata*, *Cassiä siamea*, *Cordia myxa*, *Dalbergia latifolia*, *Eriolaena hookeriana*, *Eugenia jambolana*, *Feronia elephantum*, *Ficus bengalensis*, *F. glomerata*, *F. hispida*, *F. infectoria*, *F. religiosa*, *Gmelina arborea*, *Grewia tiliaefolia*, *Hardwickia binata*, *Lannea grandis* (Syn. *Odina wodier)*, *Melia azedarach*, *Milletia auriculata*, *Moringa pterygosperma*, *Ougeinia dalbergioides*, *Pterocarpus marsupium*, *Schleichera oleosa*, *Sesbania aegyptiaca*, *S. grandiflora*,, *Stereospermum*

suaveolens, Streblus asper, Tamarindus indica, Terminalia tomentosa, Wendlandia exserta Zizyphus jujuba, Z. numularia, and *Z. xylopyra.* This list is based on information recently collected by the Provincial Silviculturist through the Forest Officers of the Province and is incorporated in a pamphlet entitled "Fodder Trees in India," published by the Central Silviculturist, Forest Research Institute, Dehra Dun. The limitations of this list are indicated in the introduction as under:

> "The list does not make any claim to scientific accuracy, but merely represents the consolidated opinions of forest officers throughout India regarding the relative suitability, or it would be better to say, the relative popularity of different tree species for lopping for fodder. It is emphasised that this list has not taken into consideration the silvicultural characteristics of the trees, so that when a tree is classified as a good fodder tree it does not necessarily mean that it would be easy to grow or would be suitable for using for making fodder leaf plantations. It will be necessary to select from the list trees which, besides being good fodder trees, are of vigorous habit, are likely to give high yields of fodder, and, above all, are suitable to the climate and soil of the locality in which it is proposed to grow fodder plantations."

As regards the desirability of raising plantations or planting trees singly under arboricultural conditions, of suitable fodder-yielding trees, *prima facie* it would appear that the scheme will have no financial attractiveness, because grazing is extremely cheap, whereas lopped fodder will not only cost money to grow but also to gather. From a purely cultural point of view also it would appear that cultivation of fodder crops or reaping of the annual crop of wild grasses will give a higher yield from an area than lopped fodder from trees grown over it; though confirmation is lacking.

Should, however, conditions alter, for instance, cheap grazing is no longer available and at the same time there is an acute demand for firewood, as in the intensively cultivated tracts of the United Provinces, there is a possibility of meeting these demands

by creating fodder-*cum*-fuel reserves. Saharanpur Taungyas* are an experiment of this kind which is proving very successful. Similar plantations could be started in the Central Provinces in suitable localities when a need arises. The technique and the choice of species will, however, need to be modified to suit local conditions.

THE CHITTAGONG HILL TRACTS FOREST DIVISION

By T. M. Coffey

PART I. THE DISTRICT

[*This Note was written in 1937. Though late, it is published now because it summarises the typical sort of difficulties and complexities with which so many forest officers in India have to deal. An apology is, however, perhaps, due to Bengal in case its late publication should suggest less progress in that Province than has actually been the case.*—Editor.]

1. *Situation and Area.*—The Chittagong Hill Tracts District is in the south-east corner of Bengal. It is bounded on the west by the District of Chittagong, south and south-east by Burma, north-east by the Lushai Hills (Assam) and north by Tippera State.

It is the third largest district in Bengal (area 5,018 square miles), being just smaller than Mymensingh and Midnapore Districts. It is a hilly country, but not mountainous as some people seem to think. I have read in an old inspection report of Mr. Milward's, Conservator, that it is very like Burma.

2. *The People.*—The population of the district is 212,922, all Mongolian, but divided up into different clans or tribes. There are at least 11 known tribes, all with distinct customs and languages—Moghs, Chakmas, Tanchangyas, Riangs, Tipperas, Pankhos, Banjogis, Lushais, Mrus, Khumis, Khyengs and Chaks. We have three big forest villages in the Chittagong Hill Tracts Division, one each at Kaptai, Mainimukh and Tinconia. All the villagers at Kaptai are Moghs, the Mainimukh ones are Chakmas (with a few Riangs) and the ones at Tinconia are Tanchangyas.

These tribes are divided up into (*a*) "sons of the mountain" and (*b*) "sons of the river." The "sons of the mountain" are those who live on the ridges; the "sons of the river" are those who live in the valleys, for example, our forest villagers. The "mountain" ones (Pankhos, Banjogis, Lushais, Mrus, Khumis and Khyengs) are very shy. They remind me of *hullucks*: very attractive but one

* U. P. Forest Bulletin No. 10 of 1937.

seldom sees them. The "river" ones (Moghs, Chakmas and Tanchangyas) are becoming quite sophisticated, especially the Chakmas, and I am afraid, losing their tribal customs of dress, language and folklore. Bengali is fast becoming the official language of the Chakma. The Riang-Tipperas live in between hill and river. They, too, are a very shy race; we have a small forest village of them at Mainimukh (14 houses). The river people are excellent boatmen and can manage dugouts in rapids and gorges with great skill and safety. They grow a lot of tobacco all along the river banks in the cold weather and make a good profit by selling it to the people of Chittagong District.

All the tribes are nomadic by tradition and definitely maintain that characteristic to this day. They live in *machan* houses built entirely of bamboo, and grow in their *jhums* a mixed crop of hill paddy, cotton, *til* and vegetables. They carry on a big export trade in cotton, but most of the paddy is kept for home consumption—eating and drinking: they like their "drop" and are always glad of an excuse for a party. Out in the district they make a visit from the Deputy Commissioner an excuse for a great feast of eating and drinking. Of course they are always poor and in debt. I believe there would be a miniature famine every year if they did not have the reserved forests, whence they extract forest produce (principally bamboos) when they are hard up and sell to Chittagong traders. Accumulation of wealth and possessions is as foreign to them as it is to an Arab. Their womenfolk are the workers; they weave, husk the paddy, carry the water and, in fact, are always busy. The men sit about, gossip and smoke their pipes or cheroots. Of course at the time of cultivation everybody works—men, women and children—and a happy party they are then, all singing and enjoying themselves in real holiday spirit, thinking of and hoping for a good crop.

The Moghs, who are very Burmese-looking and dress in Burmese fashion, are devout Buddhists; the Riang-Tipperas are mostly Hindus; many of the Lushais are Christians while the "religion" of the rest is mostly superstition and animism.

The Lushias are a very friendly race and give one a very warm welcome when one visits them on their ridges. They all shake

hands: a good many of the "lads" wear *topis* (Calcutta pattern!). It is quite amusing to see one of these small Mongolians coming along in his *topi* to shake hands—reminds one rather of a Tibetan in his Homburg! This is a big change from 1871, when a costly expedition of British and Indian troops had to be sent up to deal with them.

3. The district is divided into three circles, namely, the Bhomong, the Chakma and the Mong, with a resident Chief in each. Each circle is again subdivided into *mauzas* or blocks with a Headman in charge of each. These Chiefs have not much responsibility beyond settling tribal cases and collecting their share of the *jhum* tax (rent) from the Headmen. This *jhum* tax, Rs. 6 per *jhum* or house per year, is collected from the cultivators by the Headmen who, after keeping there share, *viz.*, Rs. 2-4 of the Rs. 6, pay the balance—Rs. 3-12 – to the Chiefs, who in turn pay a pre-arranged lump sum to Government of approximately Re. 1-4 per *jhum*. This pre-arranged lump sum is settled and decided on periodically each time the *jhum* tax is revised.

Under the new constitution the Chittagong Hill Tracts is a totally excluded area—the only one in Bengal—and comes directly under His Excellency the Governor.

4. *Communications.*—There are no cart roads (only footpaths) and, of course, no bullock carts, motor cars or railways. The principal means of communication is by river, in dugouts, and walking. Where there are not any rivers the people carry their loads on their backs, just as the Himalayan tribes do. There is a public launch service on the Karnafuli river between Chittagong and Rangamati, the headquarters of the district. These launches carry the mails and have a monopoly of the route. It is a whole day's journey and sometimes more than that—very often the launches get stuck for hours on sand-bars during the cold weather and during the monsoon when the river is in spate they get marooned for days *en route* and dare not move until the flood subsides. An alternative route by road would be a great boon, especially as there is only one telegraph office in the district—that at Rangamati, the headquarters. I am not counting the one at Chandragona which is on the district boundary.

5. *Climate.*—The climate is distinguished by one characteristic—its unhealthiness as regards foreigners. Europeans and Bengalis alike suffer very much from malaria and black-water fever. Mosquitos are humming round me now at midday while I am trying to write this note. Sandflies are also a great pest, so much so that one has to use a special small mesh net instead of the ordinary mosquito net. One does not hear of the local people suffering very much from malaria and black-water fever, but still nature must have had some reason for providing *Vitex peduncularis* all over the district, the leaves of which, when brewed, provide a decoction which is used as a first-aid in cases of black-water. I would not say that the district is fundamentally more unhealthy than districts in the Terai and Dooars at the foot of the Himalayas, but one is subconsciously inclined to think so because of the complete inaccessibility of the district from the outside world and the complete lack of efficient medical facilities. The local people also have their troubles: in certain parts of the district they are being ravaged by a peculiar hereditary disease known locally as "Maiyang." They do not seem to mind mosquitos or malaria (they certainly have not yet taken to mosquito-nets on a large scale, but that must be because they cannot afford them), but they burn ants' nests all day long during the rains to keep sandflies away.

I seem to have painted rather a gloomy picture of the climate, but in such an attractive district illnesses are rather apt to stand out and make one feel how much they spoil the picture. The forest staff suffer a good deal and that too is rather apt to magnify the anxiety of the writer who appreciates the district himself but who, in a way, shares the responsibility of their health.

The usual south-west monsoon common to this part of India occurs. The average rainfall is about 100 inches.

PART II.—THE FOREST DIVISION

A.—General Description

1. *Situation and Area.*—The reserved forests are scattered all over the district. Altogether there are 10 reserves, eight in this division and two in the Chittagong Division. The area of the reserves in this division is approximately 1,000 square miles. The

Survey of India completed their survey of the district in 1936-37; I have not yet heard the revised area of three reserves but it is anticipated that the total final area will be just over 1,000 square miles. The division is divided into three Ranges, Kassalong, headquarters Mainimukh; Sitapahar, headquarters Kaptai; and Ringkheong, headquarters Tinconia; with a Forest Ranger in charge of each. The headquarters of the division is at the district headquarters, Rangamati—a very pretty but rather unhealthy place on the Karnafuli river, a couple of hundred feet above sea level, 60 miles from Chittagong town and 63 miles from Demagri which is just inside the Lushai Hills District boundary. There are no maps yet of the district but the recent topographical survey done by the Survey of India will remedy this defect. Some of the maps will be half inch, some three-quarter inch and some one inch. The forests were, of course, surveyed at the same time and done on the same scale.

2. *The Staff of the Division* consists of one divisional forest officer, one subdivisional forest officer, six clerks, three range officers with attached deputy rangers, foresters and forest guards, four toll station officers and one timber depot officer (forest ranger) at Chittagong.

3. *Geology and Soil.*—The Burma Oil Company have done a survey (from their point of view), prospecting for oil. I understand that they found no minerals such as coal or oil. I saw a summarised copy of the report from which I have extracted the following condensed information which I publish with apologies and acknowledgments: "Sandstone and shale present; no limestone; no volcanic lavas or ashbeds and no igneous rocks such as granite and dolerite."

The soil is principally sandy loam. There is certainly laterite at Mainimukh and at Rangamati which we learnt to our cost when we tried to grow teak there: the teak started off well but stopped dead at about 10 years of age. The soil throughout the reserved forests is definitely deep, rich and fertile as can be judged from the crop of paddy our forest villagers get per acre and also from our plantations. Mr. Griffiths, I.F.S., Madras Silviculturist, tells me that our Kaptai teak is quicker in growth even than their

Nilambar Quality I teak, carries a larger volume per acre and gets its main height growth much earlier in the rotation.

4. *Types of Forest.*—The following types occur:

(*a*) { Tropical wet evergreen.
Tropical semi-evergreen.

(*b*) Tropical moist deciduous.

(*c*) Bamboo.

(*d*) Savanna.

The *marketable* species in the evergreen and semi-evergreen type can be divided into four storeys (this will be convenient later on when we discuss natural regeneration): (1) the top story consisting of *Dipterocarpus turbinatus*, *Dipterocarpus pilosus* and *Swintonia floribunda*; (2) the second storey consisting of *Artocarpus chaplasha*, *Dichopsis polyantha*, *Amoora* spp., *Eugenia* spp., *Mesua ferrea and Calophyllum polyanthum*; (3) the third storey consisting of *Taraktogenos kurzii*, *Podocarpus neriifolia* and a pole crop; (4) the fourth storey consisting of natural regeneration (seedlings and saplings) and undergrowth (weeds).

The marketable species in the deciduous type are *Tetrameles nudiflora*, *Sterculia alta*, *Bombax malabaricum*, *Cedrela toona*, *Lagerstrœmia flosreginæ*, *Gmelina arborea and Trewia nudiflora.*

Bamboos occur in the following order of quantity. *Melocana bambusoides*, *Teinostachynum dullooa*, *Babmusa tulda*, *Oxytenanthera auriculata*, *and Dendrocalamus longispathus*. The quantity available may be gauged from the fact that approximately 5,600,000 were extracted during the year 1935-36. All these were taken to Chittagong District for local use, none for industrial purposes such as paper pulp. Throughout the division there are large areas densely stocked with just pure *Melocana bambusoides*. Bamboos are also coming in naturally as an undergrowth in our teak and Gamari (*Gmelina arborea*) plantations after the first thinning.

Savanna grasses are found in the blank areas throughout the division. There are two common species. *Imperata arundinacea* (sungrass) and *Saccharum narenga* (khagra).

Cane (*Calamus* spp.) occurs throughout the evergreen and semi-evergreen type. Some of the species, for example, *Calamus latifolius* (Kerak), grow to 200 feet or more long.

There is no flora of the district. Mr. Heinig, when he was Divisional Forest Officer many years ago, prepared, from Prain's "Bengal Plants" and Gamble's "Indian Timbers," a descriptive list of the plants occurring in the district. It would indeed be a great help if this list could be corrected. We are indebted to Mr. Parkinson, I.F.S., Forest Botanist, Dehra Dun, for pointing out mistakes and for identifying new species.

5. *Fauna.*—Considering the very big area of the district and the very small population, there is very little wild life. Elephants are the only species that occur in large numbers; in a stockade *khedda* it is not unusual to catch 20 or 30 in one drive.

6. *History* (*Chronology*).—

1869—Assistant Conservator of Forests appointed to the district.

1871—Government Forests declared.

1871—Teak plantations started (at Kaptai).

1875—The first Forest Reserve (Maini Valley) created; area 339 square miles.

1893—Teak plantations stopped owing to their cost. Four hundred and thirty-three acres planted.

1905—Partition of Bengal, East Bengal including Chittagong Hill Tracts district transferred to Assam.

1905 to 1907—Illicit *jhuming* in the Maini Valley Reserved Forests.

1909—Maini Valley disafforested (337 square miles).

1909—Chittagong Hill Tracts Forest Reserves separated from Chittagong Division and became the new Chittagong Hill Tracts Division.

1912—Re-partition of Bengal.

1912—Plantations started again (total area to 31st March 1935 = 5,944 acres).

1919—Timber Depôt (one-fifth of an acre) opened at Chittagong.

1926—Area increased to half an acre.

1927-28—Depôt Officer's quarters constructed.

1929—A resident Depôt Officer appointed.

1930—Area of Depôt increased to one acre.

1932—Caterpillar petrol tractor (25 drawbar h.p.) purchased. Cost Rs. 14,100.

1933—Area of Depôt increased to 1½ acres.

B. EXPLOITATION AND UTILISATION

7. The working plan prescribes clear-felling and artificial regeneration 172 acres a year at Kaptai and 682 at Mainimukh. There is no difficulty about selling the standing crop of the whole 172 acres at Kaptai which is only 39 miles from Chittagong and has good river communications. Not so at Mainimukh which is 110 to 120 miles from Chittagong, the nearest timber market. There, the clear-felling coupe is a long distance from the river and there is not a single bullock cart or cart road in the whole of the district. So something had to be done. Timber contractors could not afford tractors or elephants, so we were faced with the problem of departmental operations and decided on a caterpillar tractor, petrol-driven, 25 drawbar h.p. at a cost of Rs. 14,100. We have also this year, been working seven elephants, so have some comparative figures to go on.

8. Ten departmental elephants are required to do as much work as the present tractor. The cost of extraction per ton per mile in the case of 10 elephants would be Rs. 6-10 as against approximately rupees eight in the case of the tractor. But the present tractor is an old model. If we had a high-powered Diesel, the cost of extraction per ton per mile would be much less because the cost of fuel would be less and it would extract twice the load of the present tractor in the same time and therefore twice the quantity in a year.

Bad and all as the present tractor may be considered by some, it is able to do the work of about 10 departmental elephants: it carries twice the load of one elephant and therefore travels five times as fast as one elephant. Besides, it does not complain of a sore back or of the heat; therefore, there is something to be said for mechanical extraction, but of course success depends a great deal on getting the right driver-mechanic; he can easily be got if we pay him, say, Rs. 200 a month. The present one cannot earn more than Rs. 100, including bonuses, and that has been the cause of a lot of our trouble in the past.

9. The net profit on last season's working with the tractor was annas five per cubic foot, which came to an average profit of Rs. 33 per tree in the case of gurjan. The outturn per acre from the current year's coupe with tractor and elephants working is expected to be approximately 500 cubic feet; therefore, the profit per acre will be Rs. 150 at annas five a cubic foot. Without the tractor or elephants we should not have been able to extract anything.

10. The average lead in last year's coupe was 1,560 yards. This is too long for elephants and increases each year (previous year it was 1,187) so the only alternative to mechanical extraction would appear to be elephant-*cum* tramway; the elephants would do all the work inside the coupe, load the tram and even drag it to the river bank.

If we decide to carry on with tractors (our next should be an "RD-6" Diesel 45 drawbar h.p.) complete with an "RD-6" Hyster Fairlead cruiser, winch and rigging. Such a tractor (standard gauge model) will cost Rs. 14,700 and the cruiser with winch and rigging another Rs. 15,000. The "RD-6" is now a standard model for timber dragging, being used in Canada, America, Australia, West Africa and British Honduras. In the latter country they first started mechanical extraction in 1924 with petrol tractors. They are now using "RD-6" Diesel caterpillars and find that their costs have been reduced considerably, besides an increase in the economic range and load. The range used to be four miles for bullock carts, then it increased to 20 miles with petrol tractors and now it is 30 miles with Diesel caterpillars.

11. With the present tractor and elephants we can work only a 200-acre coupe including *dhepas* (unproductive areas). If we get a market for our Civit (*Swintonia floribunda*)—it is now an established packing-case timber in Burma—we shall have to reduce the area of the coupe or get another tractor or more elephants. We can get 200 to 300 cubic feet of Civit per acre which would amount to 1,000 tons a year in the case of a 200-acre coupe. This would require 10 elephants or another tractor like the present one to extract it.

12. At present we extract the following (principal) species from Mainimukh, where the tractor is working. I give them in

order of quantity: we sell everything that we extract.—*Dipterocarpus turbinatus, Dipterocarpus pilosus, Dichopsis polyantha, Amoora* spp., *Eugenia* spp., *Artocarpus chaplasha, Calophyllum, polyanthum, Mesua ferrea, Lophopetalum fimbriatum* and *Lagerstrœmia flosreginæ. Swintonia floribunda* is available in large quantities (200 to 300 cubic feet per acre) but the demand is very limited at present.

All this timber is rafted to Chittagong Depôt (minimum 110 miles), where it is sold. Local demand is good for all the species that we extract, except Gurjan and *Swintonia floribunda*: but the railways (North-Western Railway and Assam-Bengal Railway especially) buy all our Gurjan, and we only extract enough *Swintonia floribunda* to meet forward orders. Latterly we have been selling about 1,000 tons (all species) a year from our Depôt, which at annas 5 per cft. gives a net profit of Rs. 15,725.

13. There is very little demand for firewood owing to lack of transport.

The demand for bamboos in the accessible areas is great. They are worked on a three-year cycle and sold on permits at full rates. All are taken to Chittagong for local use, none for industrial purposes such as paper pulp. Our five common species of bamboo (*see* paragraph 4—"Types of Forest") have been tested for paper pulp at the Forest Research Institute, Dehra Dun, and found suitable, even when mixed. We can easily sell all our accessible bamboos. There are vast areas of bamboos in the inaccessible areas available for the manufacture of paper pulp if the purchasers are prepared to invest in light portable ropeways or some form of modern extraction up to the rivers whence the bamboos can be floated to Chittagong.

The demand for cane in the accessible areas is also so great that we have had to start working it on a three-year cycle.

The difficulty of getting a market for our thinnings is causing anxiety. We have over 3,000 acres of teak plantations alone and are not getting a good price for the thinnings. Teak poles can be supplied part-seasoned—they are girdled (from second thinning onwards) at the time of marking so that they will float. The area

of our teak plantations is increasing at the rate of about 200 acres a year.

C.—SILVICULTURE

14. I have already said that the working plan prescribes clear-felling and artificial regeneration. The soil has also been briefly described above (*see* Part II, paragraph 3). The rotation is 80 years. Each felling series in the timber working circle has its own forest villagers who raise taungya plantations, that is, plantations in which forest trees are raised in combination with field crops. The forest villagers cultivate in a plantation for one season only, but they look after the plantation for two years. They do all the work there and we pay them Rs. 10 an acre. We hand a coupe over to them on the 1st January each year and they hand it back to us a fully stocked plantation two years later. Of course we do all the supervision, as well as provide all the seed and seedlings.

15. The prescribed areas of the clear-felling coupes are 172 acres at Kaptai and 682 acres at Mainimukh. We have also been clear-felling about 100 acres a year in Ringkheong Range although it is not prescribed in the Working Plan. The soil at Kaptai and Ringkheong is of the same quality and quite suitable for teak. That at Mainimukh, which is tropical evergreen forest, is an "evergreen" soil and not suitable for species such as teak, padauk (*Pterocarpus dalbergioides*) and *Gmelina arborea*.

16. Plantations were started in this division (at Kaptai) in 1871, principally teak with a small patch of 1891 mahogany (*Swietenia macrophylla*) and a few scattered 1890 padauk (*Pterocarpus dalbergioides*), and continued until 1893 when they were stopped by Mr. Dansey, Conservator of Forests, because of the cost. Actually of those old plantations only the 1873-1891 ones (433 acres) have been successful, the others (1871, 1872, 1892 and 1893) have all been written off.

The next start was made, again at Kaptai, in 1912 and has continued to this time without a break. In addition, plantations were begun at Mainimukh and in Ringkheong Range in 1920.

Teak is the principal species at Kaptai and in Ringkheong. We had to stop growing teak, also padauk, at Mainimukh, because of the soil. The principal species being grown there now are

Dichopsis polyantha, *Swietenia macrophylla* and *Dipterocarpus turbinatus*—not *pilosus* because of seed trouble—also *Lagerstrœmia flosreginæ*, *Gmelina arborea* and *Trewia nudiflora*; we cannot grow *Artocarpus chaplasha* at Mainimukh because of elephants, but *Xylia dolabriformis*, *Canarium euphyllum*, *Sterculia campanulata* and *Antocephalus indicus* are being tried. The last mentioned is an excellent packing-case timber and is being tried instead of *Gmelina arborea* which does not make a good tree shade-crop for *Dichopsis polyantha*, *Swietenia macrophylla* and *Dipterocarpus turbinatus*.

17. It appears quite likely (almost certain) that we shall be able to get natural regeneration (at Mainimukh) of species such as *Dichopsis polyantha*, *Dipterocarpus turbinatus*, *Calophyllum polyanthum*, *Amoora* spp., *Artocarpus chaplasha*, *Mesua ferrea* *Eugenia* spp., and *Traktogenos kurzii*. The Silviculturist first laid out small sample plots there, in unworked forest, in 1930, to study the possibility of natural regeneration. These experiments have been found very useful and instructive. This year (1937) we laid out an 18-acre sample plot in the 1936-37 coupe from where we had already removed all the saleable species; in a recent count we found about 4,000 seedlings there in a sample acre. A 50-acre plot in worked-over forest has been selected for a large scale experiment in 1938; if we can get natural regeneration in the worked-over area (having removed all the saleable species) so much the better.

It must not be forgotten or overlooked that even if we decide on natural regeneration we shall still have to provide for extracting the fellings (by *elephants* and *tram* or by *tractor* and *elephants*); also we shall always have to do a certain amount of clear-felling in order to have forest villages where we can get labour. The regeneration area, 682 acres, is big enough for both natural and artificial regeneration so we ought to try both and work up to half and half.

PART III.—THE DISTRICT FORESTS

1. The rest of the district—area about 4,000 square miles—(*i.e.*, the whole of the district less the reserved forests) comprises the district forests, known locally as the "Unclassed State Forests." They are directly under the Deputy Commissioner who consults the

Divisional Forest Officer when necessary on technical and other matters.

2. The customary form of cultivation in the district from time immemorial is "taungya," *i.e.,* a clearing made by cutting and burning forests in which *agricultural* crops are raised for one season only. This is a very wasteful method; what happens is this: in the inaccessible areas they (the cultivators) burn everything that they fell; and in the accessible areas they extract the bamboos and saleable timber species, burning the rest, and sell them to the Chittagonian traders at the border toll stations; what they get from the trader is entirely theirs (the trader pays even the royalty). So apart from providing land for *jhuming,* the Unclassed State forests are also a very great source of income to any hard working and enterprising person, especially when times are not too good (failure of crops, famine). These perquisites of land for *jhuming* and forest produce to sell are reserved entirely for natives of the district. Unfortunately, the goose that lays the golden egg is being gradually *jhumed* to death and, in a short time, there will not be any Unclassed State forests to *jhum,* nor produce to sell. What will happen then? Where are they going to *jhum*? In the reserved forests? The people are even now compelled to *jhum* in old *jhumed* land that is full of the weed "Assam-lata" (*Eupatorium*).

3. The revenue on forest produce extracted from the Unclassed State forests is collected by the Forest Department at border toll stations all along the district boundary. Altogether there are 24 such border toll stations, one on each river or stream approximately where that river or stream leaves the Hill Tracts District and enters the Chittagong District. The 24 include four big border toll stations, one the Feni at Amlighat, one on the Karnafuli at Fringkheong, one on the Sangoo at Dhobacheri and one on the Matamori at Manikpur. Only the one at Fringkheong is under the divisional forest officer of this Division; Divisional Forest Officer, Chittagong, manages the other three as well as the 20 small ones.

4. There are certain restrictions on the felling and extraction of forest produce from the Unclassed State forests, but somehow or other felling goes on and there is very little left now. The Forest Department is not entirely free from blame. Our job in this

particular case is to collect revenue at the toll stations and *credit it to the Forest Department.* There we think our responsibility ends, but that is a short-sighted policy; if something is not done there will not be a sustained annual yield of either produce or revenue and most of the rivers will silt up from top-wash and erosion. The weed "Assam-lata" has, to a certain extent, saved the situation for the present as far as top-wash is concerned, by holding the soil together after *jhuming.*

5. The following statement will indicate that the quantity of forest produce in the Unclassed State Forests is getting less and less:

Description.	Average annual value of produce removed, 1865-67, down the Karnafuli River*			Value of produce removed down the Karnafuli River in 1936-37†		
	Rs.	A.	P.	Rs.	A.	P.
Cane	11,433	3	4	998	0	0
Bamboos	73,072	6	4	50,298	0	0
Thatch grass	31,821	14	4	8,098	0	0
Boats	35,912	7	4	53,877	0	0
Timber	38,882	7	4			
Total ..	1,91,125	6	8	1,13,271	0	0

*From all forests; there were not any reserved forests or unclassed state forests then.
†From all forests, *i.e.*, reserved forests and unclassed state forests.

With the development of our Reserved Forests it is expected that the revenue of the division will again go up to Rs. 1,91,125, but that will not solve the troubles mentioned above in paragraph 2 about land for *jhuming* and forest produce to sell and for home consumption.

COUNTER-EROSION AND RECLAMATION SCHEME IN GUJRAT DISTRICT

BY KHEM CHAND

1.—NATURE OF DAMAGE

I have seen a large part of the area affected by torrents in this district. The counter-erosion and reclamation scheme is intended for the portion of Gujrat district, lying to the north-east of the railway line.

Seven main torrents locally known as *kasses* traverse this part of the district and drain into the Chenab river excepting one (Jaba) which drains into the Jhelum river. Of these six have their origin in Jammu territory of Kashmir State, *viz.*, Bhimbar, Bhundar, Duara, Bukul Duara, Dalli and Jaba; and the seventh, known as Halsi Kass, rises in undulating ground between the villages of Palahgiran and Shahabdiwal where its catchment drains a wide area of land, mostly cultivated, by means of a network of shallow, trough-like depressions, some of which carry permanent water in their upper reaches, derived from springs near crests of rising ground. Torrent water in this *kass* is derived from run-off from cultivation and *banjar* land and a little also from the springs. Besides, there are numerous minor torrents in the form of shallow drainage lines which originate locally in undulating ground and lead to the major torrents, or direct to the Chenab river.

The damage done by these torrents consists of:

(*i*) Invasion on habitations (*abadies*), wells and cultivated lands on either bank with widening of the beds of their courses as they rise with continuous deposition of silt (sand) carried from their catchment areas and by means of undercutting of vertical banks on the outside curves of bends.

(*ii*) Destruction of habitations, wells and cultivated land coming under their branches or entirely changed courses due to rise in their original beds.

(*iii*) Inundation, with high floods, of the low-lying lands on either bank which are thus covered with a sand layer, including danger to the habitations.

(*iv*) Carriage of sand with winds and storms from the torrent beds on to the neighbouring fields which thus become inferior in quality.

(*v*) Besides, even the original sandy beds of these major and minor torrents, varying in width up to a furlong or more, constitute a tremendous waste, and reduce the land revenue of the district.

II.—MEASURES TAKEN UP TO THE END OF 1938-39

With the object of saving culturable land, habitations and wells from ruin, five main *bunds* of sand have been put up. Of these four are designed to dam new branch courses marked out by the torrents either by side-action or by overflowing banks, such that they were following and deepening a local depression, in most cases with a more direct route to the river than that of the main course of each torrent. And the fifth *bund* between Peroshah and Handa villages is meant to divert the whole torrent into the new course.

The earthwork on the *bunds* has been done free of cost to Government by the villagers as a co-operative venture organised entirely through the efforts, tact, and persuasion of the Revenue Assistant. This constituted the main item of labour expense; while Government has contributed Rs. 6,593-1-6 to date, including Rs. 1,285-5 on planting works, for completion of the *bunds* with spurs, groynes, sand bag rivetting, plantation, etc. The District Engineer and the Forest Officer on Special duty are responsible for the skill in designing and construction work of the *bunds* and for the plantation work respectively. The Deputy Commissioner had been at the helm of all the affairs. Apparently a lot of strenuous work has been done which reflects great credit on those who have managed and supervised it.

To safeguard vulnerable points in the *bunds* and to fix the direction of the flow of the torrent, sand-spurs, hanging spurs, staking cross fixed spurs and sand groynes have been added. Also rivetting with sand-bags down to two feet below the bed-level on the stream side faces of groynes and sand-spurs and vulnerable points of the main *bunds* has been done to strengthen them all. *Shisam*, mulberry, willow, *keora*, *bakain*, tallow, etc., were planted on both sides of the *bunds*. But those in front have been washed away or

buried under silt by the floods. Hand watering was done from temporary *kachcha* wells and shade provided artificially to the plants in the dry months. There are many survivals behind two of the *bunds*. Excepting the Chak Sikandar *Bund*, which collapsed entirely, others have withstood the floods of 1938 with more or less serious damage to earthwork pitching and spurs, the repairs to which need to be completed now. All breaches were repaired at once. A sand-berm has been formed at places along the toe of the *bunds*. In all the *bunds* made, the hydraulic gradient had been kept at 1 in 8, outer slopes 3 to 1 and inner slopes: 2 to 1.

III.—SERIOUS HANDICAPS IN THE TRUE AND REALLY EFFECTIVE COUNTER-EROSION AND RECLAMATION MEASURES ON THE SIX HILL-TORRENTS

The *bunds* are raised from pure sand raked up from the torrent bed. And so are the groynes and spurs. Stone and brushwood are not available locally. The banks are, therefore, on the stream side, pitched with sand-bags which rot after a year. But even before that they might in some cases give way before a surging flood of great intensity. If, however, to strengthen vulnerable points in the *bund* and to make the groynes and spurs also invulnerable, stone-pitching be done in place of sand-bag rivetting, the cost will mount up tremendously in spite of free labour for the earthwork. And this will not be advisable, particularly in view of the torrent being capricious in its behaviour. Besides, the high cost is bound to render the scheme slow-going. And the time by which damage of this nature at all places of each of the torrents will have been attended to, even with prospects in some cases of uncertain and short-lived results, will probably never come. Thus attempts on these lines on a large scale are impossible on account of the prohibitive cost. The Government will not be able to afford to let this district alone absorb the major portion of the surplus revenue at the cost of such and other beneficent works throughout the province.

Considered from the more important and serious point of view, the *bund* building and torrent-control engineering works are very liable to prove disappointing if run-off conditions in the upper reaches of the catchment are not on the way to improvement. Poor

plant cover means more violent and sudden run-off and a larger load of sand brought down to be dumped in the lower reaches of the stream, thus causing a continual rise in the level of the entire torrent bed. This means that down-stream *bunds* and other works cannot possibly be a permanent remedy unless the run-off conditions can also be improved. The diversion *bunds* could be justified, even as an emergency measure, only where a large area of culturable land could immediately be made safe and reclaimed at least for a number of years without corresponding loss elsewhere and without incommensurate cost on continual repairs.

The hilly catchment areas of six out of the seven main torrents in this district lie in Kashmir State territory whereon we have no control whatsoever. These catchment areas are under serious erosion due to denudation and over-grazing. Thus a great volume of sand is carried down with the sudden rush of water on to the beds of the *kasses*, so that after some time the bed is raised so high that the stream finds it increasingly easy to leave its old bed and wander elsewhere. Obviously, therefore, if the erosion in the catchment area continues unchecked, it is only a matter of time before the torrent will again leave its bed either by working round the *bund* or by breaching it at some other point. Hence most of such *bunds* may only be regarded as temporary and costly expedients unless the catchment areas are brought under an efficient protection regime which will allow early restoration of the plant cover.

A diversion *bund* in some cases means merely the abrupt transfer of the problem of protection against the ravages of the torrent water to other vulnerable places along the banks down-stream. The torrents are undercutting high banks, widening themselves and overflowing into branch channels due to their beds silting up. The counter-erosion measures in the catchment areas should include closure to grazing, browsing and excessive wood cutting, encouragement of grass-cutting and stall-feeding of cattle, *watbandi* and terracing of fields and reforestation to supplement natural regeneration. These control measures will also result in immediate benefit to the villages situated in the catchment areas and in the flat cultivated portion of the Jammu territory adjoining this district. The catchment area of Duara *Kass*, for instance, covers 10 square miles of area in the upper reaches and another 10 square miles of Mirpur lowlands.

In September, 1937, the Deputy Commissioner of this district urged the Commissioner to bring some pressure to bear upon the Kashmir State Authorities to undertake control measures in the

catchment areas of these torrents. And for tackling erosion at the source, the Kashmir Durbar constituted an erosion enquiry committee, the results of whose labours however, are not known to us.

IV.—SUGGESTIONS ON FUTURE POLICY

(Mr. Hamilton's Note will be found to be very useful in this connection.)

(i) Control Measures in the Catchment Areas of the Six Hill Torrents out of the Seven Major Torrents.—As explained before, with a view to gradually decreasing the amount of silt and floods in the six major *kasses* out of the seven which traverse this district, control measures in their catchment areas lying in Jammu territory will constitute the real remedy. And for this it is necessary for the Punjab Government to do its utmost to bring pressure to bear upon the Kashmir Durbar.

(ii) Bunds.—The existing *bunds* are all in the major torrents (*kasses*) of which the catchment areas lie in Kashmir territory. Of these, the Jalalpur Jattan *Bund* is so sited that it needs considerable engineering skill and high cost of maintenance (strengthening and repairs) for some time at least. And the Chak Sikandar *Bund* still needs about as much more earthwork to be done besides all the pitching work before it can be completed. The other three *bunds* are comparatively easy to maintain and expected to serve the desired purpose at a reasonable cost. It has, therefore, been decided by the Director, Anti-Erosion Circle, Punjab, with the approval of the Civil Department, that the Jalalpur Jattan *Bund* may continue to be managed by the District Board as before; the Chak Sikandar Bund be abandoned and that the other three *bunds* be maintained by the Anti Erosion Division of the Forest Department with the help of the Revenue Officers for free labour by the zamindars and the District Engineer for technical advice. Attempts will be made to render the bunds permanently invulnerable by means of vegetable covering over and around them. For this purpose *sarut* (*sarkana*) agaves, *thohr* opuntia, tallow, castor oil plant and khabal grass may be tried.

(iii) Training of the Courses of Torrents and Reclamation of Sandy Beds by Progressive Stages.—The sandy waste behind the

bunds and elsewhere on the banks and in the beds rendered safe from torrent action by *bunds* or *watbandi* and terracing (dealt with hereafter), should be reclaimed finally for cultivation by sowing and planting *sarut*, *kikar*, castor oil plant, *phulai*, *khair*, mosquite (*P. glandulosa*), *bakain*, *shisham*, etc., according to the nature of soil at each place.

Any additional project for a large *bund* should not be undertaken. But small bunds and spurs of earth or brushwood or both combined may be found to be worth trying at places, to protect or help living hedges of *bana* (Vitex negundo), *nara* (Arundo donax) and willow, with or without *sarut* planting on the background which should be attempted by progressive stages for purposes of training or diverting of the courses of torrents and reclamation of sandy beds wherever possible and practicable. As far as possible these torrents may by training be confined to reasonable limits with a view to restrict damage by them. But it will not be advisable to resort to interference in the natural course of a torrent by means of temporary expedients at tremendous cost for saving some land in exchange for sure damage of some sort elsewhere on the torrent. The reclamation measures are to be undertaken to render the silted up beds cultivable and safe from torrent action at an earlier date.

(*iv*) *Watbandi and Terracing as a Source of Great Relief.*— The seventh main torrent, as explained before, originates within the limits of this district from a net work of minor channels and nullahs resulting from the drainage of undulating ground between the villages of Palahgiran and Shahabdiwal. The downstream course of this main torrent, known as Dalli West or Arsal *Kass*, and also the other six major hill torrents are all fed and swelled by innumerable tributaries *en route* which, likewise, originate from sloping ground on either side within this district. Besides, there are a large number of nullahs traversing the strip of country to a width varying up to 3-4 miles along the bank of the Chenab river, which likewise originate locally and then individually, or combined into larger torrents, join the river eventually.

Contour terracing and *watbandi* of the fields on either bank of all these minor torrents and the seventh major torrent will surely result in preventing all rain water from reaching their beds. This will thus stop all these local torrents, while the same remedy, applied to the fields on either bank of the six major foreign torrents, would prevent their swelling *en route*. When the locally originating torrents cease to flow after complete terracing and *watbandi*, their sandy beds can be reclaimed with vegetation, as explained before,

for purposes of cultivation. This will benefit the zamindars by addition to their culturable land and the Government through enhanced land revenue. The sandy bed of the local major torrent (Dalli West) alone covers an area of over 2,000 acres. The total area thus to be reclaimed will amount to several thousands of acres.

On sloping ground rain water rushes down to the nullah and carries with it the fertile top-soil of the fields. At places gullies are formed where the rain water runs down from the edge of a field into a depression and cuts a nullah which works back into the field. So that terracing and *watbandi* of fields on sloping ground will besides stopping local torrents, preventing foreign torrents from swelling and reclaiming lands, help to prevent both surface and gully erosion in the fields. And this would, by conserving moisture and fertile soil in the fields, increase the agricultural produce thereon.

All terracing and *watbandi* of fields should be done by the zamindars themselves; while improvement of the sandy beds for cultivation can be done at Government expense. In this scheme the strong backing and help of the revenue officers will be essential. And vigorous and incessant educative propaganda by arranging meetings and *melas* for the villagers shall be the main feature of this work. For this purpose a demonstration area of nine acres has been taken up in Kotla village close to the rest-house under the initiative and guidance of the Director, Anti-Erosion Circle, Punjab, and terracing and *watbandi* of the fields, combined with gully control measures by "economic digging" at the combined expense of Government and Zamindars have been started. Another—but smaller—such demonstration area may be also laid out near Bahlolpur. The results shall be watched during the monsoon period. To improve the lot of the zamindars in the affected area of this district, wherein cultivation is practically all on *barani* lands, the terracing and *watbandi* of cultivated land on sloping ground has to be vigorously encouraged. Some system of land-revenue remission or rewards on a simple and easily workable basis can perhaps be worked out by the Revenue Department to encourage and ensure rapid, complete and permanent land improvement. Also the advisability of arming the Divisional Forest Officer with the requisite influence over the zamindars through some revenue powers may be considered. He should at least be so empowered as to be able, without any strain on the district authorities, to influence the village officials for help and co-operation in the anti-erosion and reclamation scheme, which is at present being so kindly secured to him by the Deputy Commissioner.

V.—RAKHS

Shortage of fuel-supply is keenly felt in Gujrat City as well as in the mofussil area. Firewood is selling in the city at annas twelve per maund. To overcome this difficulty and to help the furniture industry in Gujrat, it is desirable to encourage the formation of *rakhs* on undulating and otherwise unprofitable lands by propaganda, demonstration and free supply of seeds and plants of *shisham, phulai, khair*, prospois, *kikar, bakain*, castor oil plant, etc., of which the castor oil plant can be availed of for industry in its oil. The sowing and planting suggested for reclamation purposes will also yield firewood and small timber for agricultural implements.

VI.—SUBSIDIARY MATTERS

(*a*) *Nurseries.*—To raise adequate supplies of transplants and stumps for planting out over the areas under reclamation and *rakhs* three nurseries of one *kanal* (5,445 square feet) each in area are being laid out on well-irrigated lands in suitable localities. And more will be established close to the planting sites as required.

(*b*) *Closures.*—For purposes of protection, the *bunds* and their immediate surroundings, the sown and planted up areas under reclamation and training of torrents and the *rakhs* should be closed against trespass by cattle. These closures will be arranged by private negotiations, propaganda and persuasion with the landlords.

VII.—CONCLUDING REMARKS

To create a sense of collective responsibility among the zamindars concerned, persons wielding influence with them may be got hold of and their support and sympathy enlisted. *Panchayats* and co-operative societies may be set up in the affected villages for co-operative help in the anti-erosion and reclamation measures under the *Panchayat* or Co-operative Act or with the help of revenue officers under the chairmanship of the deputy commissioner. It is necessary to dig out the zamindars from their haunts of idleness for harnessing them to a task which directly benefits them. In the beginning all the motive force is to be provided by us. But with training, experience and propaganda the zamindars will, it is hoped, develop a sense of responsibility which would, in due course, make it possible to withdraw the official initiative. Thereafter, it will only be necessary to supervise the work and where necessary, to afford technical guidance and financial assistance. If the zamindar is left in the lurch, the officers, and in consequence the Government, will expose themselves to a charge of moral delinquency.

SUMMARY OF REVENUE EXPENDITURE AND SURPLUS OF THE FOREST

Heads.	Imperial.	Bengal.	United Provinces.	Punjab.	Bihar.	Orissa.	Assam.
Revenue—							
Timber and Other Products—							
1937-38 ..	..	21,54,330	52,87,049	23,60,192	7,00,926	4,29,086	17,50,720
1938-39 ..	..	22,41,206	54,03,684	23,02,776	7,73,314	6,36,814	16,69,298
Expenditure—							
Conservancy, Maintenance and Regeneration—							
1937-38 ..	..	5,94,716	10,27,405	11,22,409	1,69,268	99,621	3,30,780
1938-39 ..	..	6,82,183	12,23,977	15,33,173	1,64,432	2,87,965	3,43,082
Establishment—							
1937-38 ..	53,837	9,69,053	18,91,119	11,27,832	3,99,875	3,32,371	8,41,469
1938-39 ..	52,626	10,10,532	18,28,330	11,22,236	4,31,224	3,55,886	8,17,631
Total of Expenditure—							
1937-38 ..	53,837	15,63,769	29,18,524	22,50,241	5,69,143	4,31,992	11,72,249
1938-39 ..	52,626	16,92,715	30,52,307	26,55,409	5,95,656	6,43,851	11,60,713
Surplus (+) or Deficit (−)—							
1937-38 ..	−53,837	+5,90,561	+23,68,525	+1,09,951	+1,31,783	−2,906	+5,78,471
1938-39 ..	−52,626	+5,48,491	+23,51,377	−3,52,633	+1,77,658	−7,037	+5,08,585

DEPARTMENT IN INDIA, FOR THE FINANCIAL YEARS 1937-38 AND 1938-39

Central Provinces and Berar.	Coorg.	North-West Frontier Province.	Ajmer.	Baluchistan.	Andamans.	F. R. I. and College.	Madras.	Bombay.	Sind.
50,50,094	4,04,546	5,12,123	83,795	1,17,761	12,88,947	1,08,921	48,57,341	43,15,039	8,29,835
48,68,288	3,13,715	5,98,819	54,250	1,74,819	16,05,609	1,50,124	43,86,944	40,60,206	8,64,687
14,62,927	88,100	1,73,218	30,589	..	9,05,131	71,046	12,60,915	6,83,558	25,763
14,00,759	69,027	1,58,730	16,268	..	10,52,315	86,947	12,37,413	6,75,024	26,153
20,57,655	1,15,211	2,17,937	34,148	..	1,68,984	5,73,347	28,34,458	20,42,860	3,27,124
19,33,348	1,15,191	2,22,871	31,602	..	1,66,613	16,27,666	27,61,371	20,12,112	3,24,575
35,20,582	2,03,311	3,91,155	64,737	97,395	10,74,115	6,44,393	40,95,373	27,26,418	3,52,887
33,34,107	1,84,218	3,81,601	48,870	1,35,976	12,18,928	7,14,613	39,98,784	26,87,136	3,50,428
+15,29,512	+2,01,235	+1,20,968	+19,058	+20,366	+2,14,832	−5,35,472	+7,61,968	+15,88,521	4,76,498
+15,34 181	1,29,497	+2,17,218	+6,380	+38,843	+3,86,681	−5,64,489	+3,88,160	+13,73,070	5,14,259

TIMBER PRICE LIST, NOVEMBER-DECEMBER, 1939

(ISSUED MONTHLY BY THE FOREST RESEARCH INSTITUTE).

Trade or Common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Baing ..	*Tetrameles nudiflora* ..	Assam ..	Logs ..	Rs. 32-0-0 per *ton in* Calcutta.
Benteak ..	*Lagerstrœmia lanceolata*	Bombay ..	Squares ..	
,, ..	,, ..	Madras ..	Logs ..	Rs. 34-6-0 to 39-1-0 per ton.
Bijasal ..	*Pterocarpus marsupium*	Bombay ..	Logs ..	
,, ..	,, ..	Madras ..	Logs ..	Rs. 50-0-0 to 61-0-0 per ton.
,, ..	,, ..	Bihar ..	Logs ..	
,, ..	,, ..	Orissa ..	Logs ..	Re. 0-9-0 to 1-4-0 per c.ft.
Blue pine ..	*Pinus excelsa* ..	N. W. F. P.	12′×10″×5″ ..	Rs. 4-8-0 per piece.
,, ..	,, ..	Punjab ..	12′×10″×5″ ..	Rs. 4-12-0 per piece.
Chir ..	*Pinus longifolia* ..	N. W. F. P.	9′×10″×5″ ..	Rs. 1-10-0 per piece.
,, ..	,, ..	Punjab ..	9′×10″×5″ ..	Rs. 2-14-0 per piece.
,, ..	,, ..	U. P. ..	9′×10″×5″ ..	Rs. 3-2-0 to 3-4-0 per sleeper.
Civit ..	*Swintonia floribunda* ..	Bengal ..	Logs ..	
Deodar ..	*Cedrus deodara* ..	Jhelum ..	Logs ..	
,, ..	,, ..	Punjab ..	9′×10″×5″ ..	Rs. 4-8-0 per piece.
Dhupa ..	*Vateria indica* ..	Madras ..	Logs ..	
Fir ..	*Abies & Picea* spp. ..	Punjab ..	10′×10″×5″ ..	Rs. 2-10-0 per piece.
Gamari ..	*Gmelina arborea* ..	Orissa ..	Logs ..	Re. 0-10-0 to 1-0-0 per c.ft.
Garjan ..	*Dipterocarpus* spp. ..	Andamans ..	Squares ..	
,, ..	,, ..	Assam ..	Squares ..	Rs. 50-0-0 per ton.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 30-0-0 to 35-0-0 per ton.
Haldu ..	*Adina cordifolia* ..	Assam ..	Squares ..	Rs. 62-8-0 per ton.
,, ..	,, ..	Bombay ..	Squares ..	
,, ..	,, ..	C. P. ..	Squares ..	Re. 0-4-0 to 0-13-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 42-3-0 to 51-9-0 per ton.
,, ..	,, ..	Bihar ..	Logs ..	
,, ..	,, ..	Orissa ..	Logs ..	Re. 0-4-0 to 0-10-0 per c. ft.
Hopea ..	*Hopea parviflora* ..	Madras ..	B. G. sleepers	Rs. 6-0-0 each.
Indian Rosewood ..	*Dalbergia latifolia* ..	Bombay ..	Logs ..	
,, ..	,, ..	C. P. ..	Logs ..	Re. 1-0-0 to 1-2-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Re. 0-12-0 to 1-0-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 80-0-0 to 100-0-0 per ton.
Irul ..	*Xylia xylocarpa* ..	Madras ..	B. G. sleepers	Rs. 6-0-0 each.
Kindal ..	*Terminalia paniculata* ..	Madras ..	Logs ..	Rs. 43-12-0 per ton.

Trade or Common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Laurel ..	*Terminalia tomentosa* ..	Bombay ..	Logs ..	
,, ..	,, ..	C. P. ..	Squares ..	Re. 0-12-0 per c.ft.
,, ..	,, ..	Bihar ..	Logs ..	
,, ..	,, ..	Orissa ..	Logs ..	Re. 0-6-0 to 0-10-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 40-14-0 to 50-0-0 per ton.
Mesua ..	*Mesua ferrea* ..	Madras ..	B. G. sleepers..	Rs. 6-0-0 each.
Mulberry ..	*Morus alba* ..	Punjab ..	Logs ..	
Padauk ..	*Pterocarpus dalbergioides*	Andamans ..	Squares ..	
Sal ..	*Shorea robusta* ..	Assam ..	Logs ..	Rs. 31-4-0 to 62-8-0 per ton.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 5-12-0 each.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 2-9-3 each.
,, ..	,, ..	Bengal ..	Logs ..	Rs.20-0-0 to 75-0-0 per ton.
,, ..	,, ..	Bihar ..	Logs ..	
,, ..	,, ..	,, ..	B. G. sleepers	
,, ..	,, ..	,, ..	M. G. sleepers	
,, ..	,, ..	C. P. ..	Logs ..	Rs. 1-2-0 to 1-4-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Re. 0-8-0 to 1-2-0 per c.ft.
,, ..	,, ..	U. P. ..	Logs	Re. 1-2-0 to 1-6-0 per c.ft.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 2-4-0 to 2-8-0 per sleeper.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-14-0 to 6-0-0 per sleeper.
Sandalwood ..	*Santalum album* ..	Madras ..	Billets ..	Rs. 306-0-0 to 639-0-0 per ton.
Sandan ..	*Ougeinia dalbergioides* ..	C. P. ..	Logs ..	Re. 0-14-0 to 1-2-0 per c.ft.
,, ..	,, ..	Bihar ..	Logs ..	
,, ..	,, ..	Orissa ..	Logs ..	Re. 0-12-0 per c.ft.
Semul ..	*Bombax malabaricum* ..	Assam ..	Logs ..	Rs. 35-0-0 per ton in Calcutta.
,, ..	,, ..	Bihar ..	Scantlings ..	
,, ..	,, ..	Madras ..	Logs	
Sissoo ..	*Dalbergia sissoo* ..	Punjab ..	Logs ..	Re. 0-11-0 to 1-0-0 per c.ft.
,, ..	,, ..	U. P. ..	Logs ..	Re. 0-12-0 to 1-8-9 per c.ft.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 35-0-0 to 75-0-0 per ton.
Sundri ..	*Heritiera* spp. ..	Bengal ..	Logs ..	Rs. 20-0-0 to 25-0-0 per ton.
Teak ..	*Tectona grandis* ..	Calcutta ..	Logs 1st class	
,, ..	,, ..	,, ..	Logs 2nd class	
,, ..	,, ..	C. P. ..	Logs ..	Re. 0-10-4 to 2-4-2 per c.ft.
,, ..	,, ..	,, ..	Squares ..	Rs. 1-8-4 to 3-1-4 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 75-0-0 to 121-14-0 per ton.
,, ..	,, ..	Bombay ..	Logs ..	
,, ..	,, ..	,, ..	M. G. sleepers	
White dhup ..	*Canarium euphyllum* ..	Andamans ..	Logs	

EXTRACTS

CHOTA NAGPUR PRIVATE FOREST BILL

WHY IT IS NECESSARY

PROBLEMS OF DIFFERENT DISTRICTS

Readers from Chota Nagpur who may read this article should be careful not to look at this problem from the point of view of their own district. The problem is different in each district. In some parts of the Ranchi district there is no forest. In other parts, the sal forest still looks extensive from a distance, but is actually

honeycombed with cultivation and will disappear altogether in a few years. In other places either landlords, or tenants, or both have tried to preserve the few remaining areas of forest. But the race for destruction between landlords and tenants has, in most places resulted in the virtual disappearance of the forest. Generally speaking, in the greater part of the Ranchi District, it is too late to undertake any sort of large-scale preservation of forest. Where there are still considerable areas of forest, as in the north-east corner of the district, efforts have already been made to bring suitable areas under the Forest Department. Along the Damodar Valley and to the south of that valley action is imperative. Some of these forests can still be saved in the interest of the local people and the country in general. In the south-west and the south-east of the district there are still large areas of forest, but these are so honeycombed with cultivation that it is extremely difficult now to do anything to save them.

In Manbhum the picture is similar to that in Ranchi, except that the destruction in Manbhum started earlier and is more complete than in some parts of Ranchi. There are, however, still some hilly areas which can be saved from the fate of the bare rocky hills which are a feature of the landscape in this district.

Hazaribagh District offers by far the greatest scope for a system of preservation of forests. There are still more than 3,500 square miles of forest in the district. Of this only a little over 200 square miles is systematically preserved, most of this preserved area being the reserved forest created when the Ramgarh Raj was under the Court of Wards. There are still vast areas of forests where villages are few and far between.

Only in the south-west of the district do we find that feature so common in the Ranchi District—*sal* forests honeycombed with cultivation. The reason has been already explained. In the greater part of the district, where the vast forests survive, the climate is too dry for cultivation. Here there is an excellent field for development of forests. We might expect to find the forest a source of wealth to landlords and of timber for agricultural and domestic purposes and fuel to the tenants. But that, unfortunately, is not the state of affairs. The forest has for generations

been wasted and damaged and destroyed in many ways, some of which are set out briefly below:

CAUSES OF DESTRUCTION OF FOREST

(1) *Destruction by Contractors.*—It is the practice of many landlords, when they are in need of ready money, to give a lease of an area of forest to a contractor. Within the last few years many new firms of such contractors—nearly all Punjabis—have set up business in Hazaribagh District. Few restrictions, if any, are placed upon the work of the contractors, who extract the last pice worth out of the forest and leave it in a completely devastated condition, even the young *sal* saplings being cut in many cases and the very stumps of the trees uprooted. This is a most wasteful method of exploiting a forest. Under scientific management a forest will yield its harvest at proper intervals and will continue to improve. Under the methods followed by irresponsible and uncontrolled contractors a forest is often destroyed beyond hope of recovery. And what about the rights of the tenants in the forests so destroyed? Usually the record-of-rights gives them certain rights to take timber and fuel. Too often these rights are destroyed without the tenants having a chance to protest. The new Bill will meet that evil.

(2) *Destruction by Tenants.*—The record-of-rights generally gives the tenants the right to cut trees below a certain girth for household and agricultural purposes. This right is too often grossly abused by the tenants. A pernicious practice has grown up in the Hazaribagh District and a few other parts of Chota Nagpur, where *sal* forest survives, whereby the tenants, every year, cut down the young *sal* saplings by the thousand and use them for fencing their bari lands and for fuel. The fencing is often done in a most extravagant manner, so that 50 yards of fencing may contain 500 young *sal* trees jammed together. In one medium sized basti the writer estimated this year that 40,000 *sal* saplings had been cut from the neighbouring forest for fencing. The extent of

the waste can be imagined if we put a value of only one rupee per tree on each of these trees, provided it were allowed to grow for another 12 years. And this waste is annual. What is the result? There are places in the Hazaribagh District where the traveller can stand on a hillock and see continuous *sal* forest stretching as far as the eye can reach in all directions and hardly a tree more than six feet high will be visible. Of what use is the record-of-rights to the ryots under such conditions? They have the right to take timber from the forest for their reasonable requirements for rebuilding their houses. But owing to the annual wasteful cutting of the young trees there is never any timber in the forest. Let it be admitted that it is partly the fault of the record-of-rights. The ryots may take small trees; the big trees belong to the landlord. The landlord sells the forest to a contractor who levels it to the ground. The tenants feel that they have no interest in letting the forest grow up because the landlord will again get it cut down by a contractor. The landlord is helpless because he cannot stop the ryots from cutting the saplings. Hence a dead-lock, the only solution of which is legislation like that now contemplated. The alternative is the waste of a national asset and untold harm to the country and the spread of the desert and of famine.

(3) *Wasteful Methods of Felling Trees.*—If one will take a walk through a forest where felling has been done under the control of the Forest Department and then through another forest where unskilled felling has been done, one will notice great differences. Trees properly felled are cut close to the ground. This enables the young shoots to come up the following year and to grow into tall, straight trees. But unskilled or careless woodmen often leave a stump three or four feet high. This means that the young trees that grow from the stump will be deformed and comparatively worthless. This is only one of the ways in which much more value can be got out of a forest under proper scientific management.

(4) *Fire.*—The forests in the Hazaribagh District and other parts of Chota Nagpur are burnt every year with calamitous results. The fires are sometimes due to the burning of leaves under *mahua* trees, the fires being carelessly allowed to spread through the forest. But frequently the fires are deliberately lit. There is widespread superstition that burning the forest causes better grazing the following year. There is no foundation for this belief. The result of annual fires is to destroy all the leaves which ought to make good soil in the forest, the surface of the soil becomes hard and infertile. Hardly any grass grows. So harmful has this process of annual burning become that in the Hazaribagh District, even in areas favourable for cultivation, it does not pay to clear jungle for cultivation. Formerly, when the pioneers cleared the forest, they found a good depth of excellent soil, the accumulation of many years' leaf-mould. Now there is nothing but hard and infertile soil. Fire destroys thousands of young trees, and those which survive are often crooked or internally damaged so that even if allowed to grow up they will be worthless as timber.

(5) *Grazing.*—Grazing does little harm to a well established forest, and, in fact, for the last two years, free grazing by tenants has been allowed in the reserved forests of the Ramgarh Raj. But under certain circumstances it may do harm and should be controlled. In a forest where young trees are coming up, after the forest has been felled, grazing should be stopped for the first few years until the trees have had a chance to grow.

(6) *Forests on Hill-sides.*—But the greatest damage is done on the steep hillsides. It is essential to preserve forests on the steep hillsides. The land is of no use for cultivation or for any purpose except forest. But the constant roaming of heavy cattle and buffaloes on the hills, especially in the rains, breaks down the soil and greatly helps the evil influences of erosion. On steep hills grazing should be controlled and every care should be

taken to preserve the vegetation on the hills. Forest-clad hills give perennial springs; they hold up the sub-soil water and so help the cultivation on the level ground, and they have a marked influence on the climate. In Hazaribagh District, where the great problem of cultivation is the shortness of the rainfall, it is the duty of every citizen to do what he can to save the forest on the hill-sides.

(7) *Removal of Saplings by Lorries.*—Of recent years the exploitation of forests has increased to an alarming extent. Hundreds of square miles of forest have been cleared and the timber carted off by contractors to the railway stations. Another disquieting feature is the growing use of motor lorries to cart brushwood and saplings. A few weeks ago, on the "Ghat" between Ranchi and Ramgarh, two large lorries were seen on the road-side loading up brushwood cut from the steep hill-sides above and below the Public Works Department Road. This process, if not checked now, means that the vegetation on the "Ghats" will disappear and landslides and damage to the roads will follow.

Enough has been said to show that the problem of forests is extremely serious and has grown rapidly more serious of recent years. No government can afford to ignore the situation any longer. For climatic reasons, in the interests of the people who live near the forests and in the general interest of the province, it is essential that steps be taken to prevent the waste of the forest resources of the country.—*The Search Light, Patna, September 28, 1939.*

THE 'ACRIDIFUGE' ACTION OF AN EXTRACT FROM THE LEAVES OF MELIA AZEDARACH *

BY M. VOLKONSKY

Translated by Mr. Taqi Ahsan, Pasni.

Melia Azedarach L ("paraiso," Indian Lilac, margosa) is a tree belonging to the family *Meliaceae* and is found in the tropical and

* Translated from the Archives de l' Institute Pasteur d' Algeri de l' Institute Pasteur d' Algerie, Alger.

sub-tropical countries of both hemispheres. Introduced as an ornamental plant, it has spread in North Africa from the coast into the interior as far as the Oases.

Different parts of the plant are known to be in use in pharmaceutics as bases of tonic medicines, antipyretics and vermifuges. M. H. Bocqillon has isolated an alkaloid—"la *paraisine*"—which is soluble in petrol-ether, benzine and chloroform.

Kuncket d' Herculais* and Carlos Thys† have already mentioned *Melia* as a type of plant which is avoided by the Desert Locust. Several persons who have had opportunities of observing invasions of locusts have confirmed this quality of *Melia*. We were thus led to investigate the insectifuge properties of this plant on our brood of locusts and to see if these properties could be utilised for the protection of cultivated plants.

Five species of locusts studied in this connection, *i.e.*, *Schistocerca gregaria, Locusta mibratoria, Anacridium agytium, Calliptamus italicus* and *Dociostaurus maroccanus*,‡ have been found to be repelled by the leaves of *Melia*. Plants sprayed with the extract of *Melia* leaves are likewise avoided by locusts. The forced feeding of a part of the leaf or of a drop squeezed out of a crushed leaf, however, did not produce any apparent toxic effect. It appears, therefore, that the action on locusts is chiefly of a repulsive nature, probably, gustatory, in character. It may happen that locusts, forced by hunger, may bite into a sprayed leaf, but forthwith they give it up and begin to rub their mandibles with their feet. When locusts are put on leaves sprayed with different concentrations of *Melia*, they first select the non-sprayed leaves and later on take the sprayed leaves in the order of the strength of the spray, but absolutely refuse them at a degree of concentration which varies in regard to the different species. Locusts may indeed be left over five to six days in the sun at a temperature of above 30°C., without touching any of the sprayed leaves. This

* Kuncket d' Herculais—"Les Acridiens, vulgo Sauterelles, et leurs invasions en Algerie, 1888—1894."

† Carlos Thys—El jardin botanico de Buenos-Ayres Jacobo Peuser, edit. 1910.

Note.—Of all the species included in the present list **Melia azedarach (Paraiso)** is the most resistant, and may be considered as completely protected from damage by locusts (p. 173).

‡ The Moroccan locusts were kindly supplied to us by M. R. Pasquier.

phenomenon, which is uniformly constant, therefore, constitutes a biological test which permits of the effect of different concentrations of the active principle being determined.

The experiment is not very conclusive in the case of hoppers because of their propensity for cannibalism. Any individual in the process of moulting, or even merely enfeebled, is at once devoured by others and it is, therefore, difficult to ensure complete starvation. In adults, on the contrary, the experiment brings about a progressive enfeeblement, which may lead to death by starvation.

For the comparison of different extracts and the study of active concentrations, we specially used two species: *Locusta migratoria* (on oat leaves) and *Schistocerca gregaria* (on turnip leaves).* Locusts (40 individuals in preliminary experiments and 100 in final experiments) were kept, for six to seven days, in a cage along with twenty leaves sprayed with *Melia* extract. These leaves were inserted into numbered holes in the lids of two vessels filled with water, the leaves and water being changed every day. Locusts were let in only after the extract sprayed over the leaves had dried up.

The extracts obtained in a concentrated condition were diluted with water before use, and in case the solvent was non-miscible in water, the extract was evaporated, treated with alcohol and then diluted with water.

Desiccation of leaves at 37°C. does not destroy the active principle, and this facilitates the keeping of the raw material. The percentages of concentrations of extracts given below always have reference to the relative weight of powdered dry leaves utilised for extraction.†

The active principle is extracted with hot water, methyl and ethyl alcohols, choloroform and benzine, but not with petrol-ether. If the alcoholic extract is fractionated with chloroform and water, the active principle separates into two layers. If under the same conditions, instead of chloroform, petrol-ether is employed, it

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* The leaves of crucifers (radish, turnip, rocket, "julienne") are some of the preferred food plants of Desert Locust.

† 100 grms. of fresh leaves give on an average 30 grms. of dry leaves.

dissolves in water completely without separation. It is believed that the principle is not *paraisine*, which is easily soluble in petrol-ether, but perhaps a derivative of that alkaloid.

The extracts in benzine, chloroform, ethyl alcohol at 95°, pure methyl alcohol and methylated spirit are equally active, wherefore, we have reason to believe that the extraction of the active principle by these solvents is satisfactory. The repulsive effect becomes manifest even with extracts at 0.1 per cent. strength. The effective dose for the Desert Locust is 2 per cent. and for other locusts, 5 per cent.

In practice, extraction with methylated spirit by reason of its lower cost is imperative. The extract obtained by means of a continuous extraction apparatus is concentrated by gentle heat and the use of a water-pump. The solution is thus reduced to one-fifth of the weight of leaves used. It is a greenish-black mass, syrupy while hot, pasty when cold, containing, besides the active principle, the "lipoids" and "carotenoids" of chlorophyl. This raw extract can be utilised satisfactorily. To facilitate emulsification in water later, 20 per cent. glycerine may be added. While using, the mass is diluted with water (250 times its weight for Desert Locust, 100 times its weight for other species). The mass is mixed with a small quantity of water in a vessel and the mixture filtered through a cloth. The remnant is ground again till the whole material is dissolved. Briny water can be used in the same manner as sweet water. A green, turbid liquid is thus obtained which keeps stable for two to three days. It feebly retains the odour of the infusion and possesses a very slightly bitter taste. The bitterness imparted to the sprayed plants is imperceptible.

We have tested the protective action of the *Melia* extract on a series of cultivated plants, such as—

Fruit plants.—Apple, plum, almond and vine.
Vegetables.—Cabbage, turnip, radish, salad and potato.
Cereals.—Maize, wheat, barley, oat and millet.

Having found by trial that the extract is equally effective in the case of various wild plants (mint, for example) and that the repulsive effect was, in no case, found affected by the odour or

taste of the plants experimented upon, we have come to the conclusion that no practical purpose would be served by enlarging the list of such plants and that the protection conferred against the locusts experimented with may be considered to be a general one, irrespective of the plants sprayed on.

A rapid washing of sprayed leaves does not diminish the repellent effect. On the contrary, it appears to slightly enhance it, as a result of its leading to a better exposure of the active principle. The "insectifuge" action, therefore, resists rainfall. It resists equally the intense action of the sunlight, for at least six to seven days. This has been shown by the experiments conducted in Algeria in July-August when the temperature reached up to 42°C.

The protective action being of a local character, spraying should be done as thoroughly as possible. Moroccan locusts were put in a cage which was placed over barley seedlings sprayed with the extract, when the locusts avoided the leaves, but ultimately attacked the stems from the base which had not been thoroughly covered by the spray. On the contrary, non-sprayed leaves, even when mixed up in the proportion of one in ten or twenty with sprayed leaves, are avoided.

Melia extract should, therefore, be utilised, above all for the protection of very valuable cultivation, which would justify the cost of a very careful and thorough spraying.

The extract, at the strength of the doses utilised, has no repulsive or toxic action on higher animals: two guinea-pigs, four rabbits, two sheep and one calf were fed for fifteen days on grass abundantly sprayed with *Melia* extract without their evincing any physiological disturbance. The consumption of three kilogrammes of medlars sprayed with 5 per cent. extract caused no bad effect on man.

All our experiments have been conducted on reared locusts and a test under natural conditions has not been possible on account of the absence of swarms in North Africa in 1936-37. We have nothing beyond in direct indications as to what the behaviour of locust swarms would be towards cultivation sprayed with *Melia* extract. Kuncket d' Herculais (cited above) observes, in this

connection, that spraying with hydrated lime and flowers of sulphur protected vines from the Moroccan locust. We have observed in cage experiments that the repulsive effect of these two substances is far less marked than that of even very dilute *Melia* extract.

We, therefore, believe that *Melia* extract could be utilised for the protection of cultivation against locusts. On the one hand, the leaves can be collected and dried for use by cultivators themselves, for being utilised, when needed, for the preparation of 2 to 5 per cent. decoctions. We have estimated that a tree, eight metres high, can provide 400 kilogrammes of leaves (dry weight) in July-August, a quantity sufficient for spraying twenty to sixty hectares of vine cultivation. One may anticipate that if the process proves satisfactory, the cultivators might grow a certain number of these trees on their lands sufficient for protecting their own cultivation themselves. On the other hand, the extract can be preserved in a concentrated form (four to ten kgs. of extract in a cask).

The use of *Melia* extract by no means interferes with the use of poisoned baits. On the contrary, the two methods will, with advantage, be complementary to each other—spraying the surrounding cultivation serving to drive the locusts towards the baits. The effective dose of the active principle might vary according to the conditions obtainable in the country (the vegetation being dense or sparse, fresh or dry). Experience alone can indicate the specific conditions to which this method could be extended and the exact lines that should be adopted, but we may confidently advocate the trial of a spraying of *Melia* extract and we put ourselves at the disposal of all interested persons for the supply of any information that may be needed.—*Agriculture and Livestock in India, Vol. IX, Part III, May* 1939.

FACTS ABOUT INDIAN LAUREL WOOD

To the Editor of the "Timber Trades Journal"

Dear Sir,

With reference to the interesting article by "J. W." *in your* issue of July 8, I should like to be allowed to make a few remarks, as I originally introduced Indian Laurel wood to this market.

First of all, "J. W." says this wood is "rather too expensive for general use." I submit that it is not more costly than, and perhaps not so costly as, woods of equal quality, appearance, and value—say Spanish mahogany, satinwood, Italian or other walnuts, the best forms of oak, etc.

"J. W." is misinformed in remarking that it has only been imported in round logs. In addition to round logs, we have imported square logs, and prime quality sawn planks and boards, square-edged. A larger volume of square-edged boards and planks would be forthcoming if a sufficient demand warranted such an import.

While it is true that the hearts of some logs are somewhat faulty, if properly handled the waste factor should not be greater than in the case of the other fine woods enumerated.

"J. W." refers to what he calls "its bad habits when naturally dried." I wish to point out that there is no such thing as "natural drying." The whole process, from the time the tree is cut down until its product reaches the joiners' or cabinet-makers' shops is artificial and I do not know any high-class decorative wood comparable with that of Indian Laurel wood which is more easily seasoned by a proper kilning process. Moreover, its standing qualities are remarkable.

My room in this office is panelled with Indian Laurel wood, which was originally sawn out of fresh logs and made into the panelling which was exhibited in the Burma Pavilion at the Wembley Exhibition in 1924. No shrinkage or any other trouble has been experienced from the start to the finish.

At the same exhibition, in the Indian Pavilion, the magnificent panelling of Mr. James Roger's billiard room and the table provided by Burroughes and Watts were also produced from fresh logs, kiln-dried, with an equally satisfactory result.

In another important building a large number of solid two-inch doors, as well as a revolving door at the entrance, gave a like successful result.

No finer examples could possibly be seen than in the large committee room at India House, where the Laurel wood is displayed with great taste and judgment, under Sir Herbert Baker's design; or the two great panels in the London County Hall, of

which I personally heard Her Majesty Queen Mary make special remark at the time when the Council Hall was opened by the King and Queen.

I am confident that anyone who took the opportunity of inspecting some of the well-known examples to which I have referred would come to the conclusion that it would be difficult to overstate the decorative merit of this wood. Yours faithfully, ALEXANDER L. HOWARD, Romney House, Marsham Street, S.W.1., July 20.—*The Timber Trades Journal*, Vol. CL, No. 3283, dated 29th July, 1939.

PLASTICS FUSE "WOVEN WOOD"

Panels made with permanently finished wood veneer, fabricated by treating skilfully woven strips with plastics, are now available to furniture designers, interior decorators, architects and others interested in a finishing material which combines durability with beauty. The Parkwood Corporation, in conjunction with engineers of General Electric's Plastics Department, made the new panel material available.

The veneer is coated and impregnated with G-E Textolite resin varnishes and a remarkable toughness is the result. After cutting the veneer into strips of the desired width, close, accurate weaving is possible. But further treatment is necessary to fuse the woven sheets into satin-surfaced, durable panels that can be cut and worked with practical application.

In order to produce such panels, the woven sheets of impregnated wood veneer are cut to the desired sizes and are bonded to Textolite laminated material under heat and pressure. The desired tough, resilient and smooth surfaces are the result.

The finished panels, in thicknesses of 3-64 or 0.020 inch, have a variety of applications. Mounted on ordinary plywood or other solid backing, Parkwood Textolite constitutes a fine new finish for such objects as desks, card tables, cabinets, bars walls and ceilings. Unaffected by moisture, alcohol, finger-nail polish and most common acids, the material is also resistant to cigarette burns.

In the 0.020-inch thickness, it is surprisingly flexible and can be stitched, stapled and cut with ordinary shears like a piece of leather. In either thickness it can be formed, cut and applied by ordinary wood-working methods.

A panel of Parkwood Textolite, after the final treatment, has a surface almost as smooth as glass and a pattern that looks like a fine, highly polished mosaic. Numerous effects are available through the combination, in weaving, of various light and dark woods. Panels are ordinarily made with the light or dark red mahogany; avodire, a golden-shaded wood imported from the Ivory Coast of Africa; birch, either red or white; new England maple; and walnut.—*The Scientific American*, Vol. 161, No. 2, August, 1939.

PRODUCTIVITY OF FORESTS

Mr. Lawrence Mason, Inspector-General of Forests, addressed the delegates to the 5th Silvicultural Conference at Dehra Dun last week. Representatives from the various Indian Provinces and from seven of the Indian States, who had been devoting considerable attention to forests and silvicultural research, attended the Conference. Knowing as we do that our forest resources are very considerable and that they should be carefully husbanded and exploited for the Nation's advantage, such a conference is bound to be of undoubted value. The aim of silvicultural research, as Mr. Mason has pointed out, is to improve and increase the productivity of our forests, most of which are producing only a tithe of what they are capable of producing. Mr. Mason's stress on the need for the closest co-operation between research workers in the Provinces and States, as well as continuity of work in this behalf and the necessity for avoiding constant changes in the personnel of research staffs is, by no means, superfluous. While research workers explore the possibilities of making the forests yield of their best, other men as intensively bent on the utilisation of the produce—major and minor—must be busy finding out new ways of using such produce to provide employment and income to industrial workers.—*The Hindustan Times,* 14th November, 1939.

The following information is taken from the statement relating to the

IMPORTS

ARTICLES	QUANTITY (cubic tons)					
	MONTH OF SEPTEMBER			7 MONTHS, 1ST APRIL TO 31ST OCTOBER.		
	1937	1938	1939	1937	1938	1939
WOOD AND TIMBER						
Teakwood—						
Siam ..	59	32	..	579	686	30
French Indo-China	..	148	25	1,482	2,700	2,745
Burma ..	14,800	15,548	9,184	91,945	90,679	83,594
Java ..	56	10	248	2,867	1,800	1,947
Other countries ..	2	10	..	519	20	..
Total ..	14,917	15,748	9,457	97,392	95,885	88,316
Other than Teak—						
Softwoods ..	2 547	1,078	14	11,584	9,018	6,4C6
Matchwoods ..	780	617	179	6,263	5,469	4,826
Unspecified (value)						
Firewood ..	..	..	..	..	..	..
Sandalwood ..	..	..	..	..	..	..
Total ..	3,327	1,695	193	17,847	14,487	11,292
Manufactures of Wood and Timber—						
Furniture and Cabinetware ..	..	..	..	..	..	..
Sleepers of wood ..	128	27	176	457	176	1,040
Plywood (tons) ..	225	461	208	3,096	2,908	3,968
Other manufactures of wood (value) ..	..	..	..	..	..	..
Total ..	353	488	384	3,553	3,084	5,008
Total Volume of Wood and Timber ..	..	..	..	..	..	..
Other Products of Wood and Timber—						
Wood pulp (cwt.) ..	15,320	13,598	10,415	1,25,797	1,69,175	1,02,684

Seaborne Trade and Navigation of British India for October 1939 :

IMPORTS

ARTICLES	VALUE (Rupees)					
	MONTH OF SEPTEMBER			7 MONTHS, 1ST APRIL TO 31ST OCTOBER		
	1937	1938	1939	1937	1938	1939
WOOD AND TIMBER						
Teakwood—						
Siam ..	10,187	5,030	..	71,668	89,124	3,336
French Indo-China	..	17,612	3,467	1,70,224	3,28,629	2,96,559
Burma ..	18,32,851	19,92,811	11,01,327	1,16,53,762	1,20,98,308	1,04,09,547
Java ..	8,701	1,694	25,735	3,60,755	1,73,044	2,01,330
Other countries ..	1,243	1,695	..	57,439	2,501	..
Total ..	18,52,982	20,18,242	11,30,529	1,23,13,848	1,26,91,606	1,09,10,772
Other than Teak—						
Softwoods ..	2,11,726	59,537	1,596	8,87,221	6,39,080	4,35,580
Matchwoods ..	48,035	40,780	10,189	3,79,386	3,67,450	3,37,181
Unspecified (value)						
Firewood ..	420	478	885	5,232	5,979	4,555
Sandalwood ..	10,071	1,920	2,565	33,499	15,399	39,063
Total ..	2,70,252	1,02,715	15,235	13,05,338	10,27,908	8,07,379
Manufactures of Wood and Timber—						
Furniture and Cabinetware ..	1,80,445	1,17,332	48,428	13,43,639	9,98,728	8,21,756
Sleepers of wood ..	12,024	9,750	21,683	66,189	31,891	1,39,267
Plywood (tons) ..	46,681	1,02,547	40,345	6,54,159	6,57,247	7,52,366
Other manufactures of wood (value) ..	1,26,565	1,82,484	85,619	10,53,065	9,86,244	8,67,394
Total ..	3,65,715	4,12,113	1,96,075	31,17,032	26,74,110	25,80,783
Total value of Wood and Timber ..	25,82,554	26,84,392	13,94,712	1,68,02,818	1,72,22,955	1,49,42,425
Other Products of Wood and Timber—						
Wood pulp (cwt.) ..	1,07,102	1,27,888	64,487	9,61,371	16,33,357	7,18,323

EXPORTS

ARTICLES	QUANTITY (CUBIC TONS)					
	MONTH OF SEPTEMBER			7 MONTHS, 1ST APRIL TO 31ST OCTOBER		
	1937	1938	1939	1937	1938	1939
WOOD AND TIMBER						
Teakwood—						
To United Kingdom	40	35	..	179	37	20
„ Germany ..	..	..	..	..	1	..
„ Iraq ..	1	7	1	101	158	269
„ Ceylon ..	..	..	..	1	1	30
„ Union of South Africa ..	..	..	..	..	..	..
„ Portuguese East Africa ..	..	..	..	..	..	..
„ United States of America ..	..	..	..	..	..	..
„ Other countries	66	234	94	425	1,161	1,068
Total ..	107	276	95	706	1,358	1,387
Teak keys (tons) ..	..	..	..	..	..	..
Hardwoods other than teak ..	5	..	..	15	..	..
Unspecified (value)						
Firewood ..	..	..	..	..	..	..
Total ..	5	..	..	15	..	..
Sandalwood—						
To United Kingdom	..	..	..	13	11	..
„ Japan ..	10	20	..	33	43	51
„ United States of America ..	64	120	10	382	307	232
„ Other countries	23	26	17	220	94	146
Total ..	97	166	27	648	455	429
Manufactures of Wood and Timber other than Furniture and Cabinetware (value)	..	..	..	..	..	..
Total volume of Wood and Timber ..	..	..	..	..	..	..
Other Products of Wood and Timber	..	..	..	..	..	..

EXPORTS

ARTICLES	VALUE (RUPEES)					
	MONTH OF SEPTEMBER.			7 MONTHS, 1ST APRIL TO 31ST OCTOBER		
	1937	1938	1939	1937	1938	1939
WOOD AND TIMBER						
Teakwood—						
To United Kingdom	5,000	4,344	..	24,775	4,719	2,600
„ Germany ..	..	..	..	..	150	..
„ Iraq ..	130	2,077	183	22,729	46,920	55,134
„ Ceylon ..	..	44	..	146	198	2,145
„ Union of South Africa ..	..	..	..	..	..	..
„ Portuguese East Africa ..	..	..	..	..	..	..
„ United States of America ..	..	..	..	..	..	..
„ Other countries	20,522	94,206	36,222	1,18,509	4,12,884	2,32,816
Total ..	25,652	1,00,671	36,405	1,66,159	4,64,871	2,92,695
Teak keys (tons) ..	..	..	..	..	..	..
Hardwoods other than teak ..	1,480	..	..	4,020	72	..
Unspecified (value) Firewood ..	..	..	..	1,027	..	..
Total ..	1,480	..	..	5,047	72	..
Sandalwood—						
To United Kingdom	..	..	..	13,480	12,380	..
„ Japan ..	10,100	20,000	..	33,510	45,153	54,025
„ United States of America ..	64,600	1,20.080	8,000	3,81,440	3,14,480	2,45,810
„ Other countries	20,020	25,127	17,810	2,20,487	95,296	1,34,793
Total ..	94,720	1,65,207	25,810	6,48,917	4,67,309	4,34,628
Manufactures of Wood and Timber other than Furniture and Cabinetware (value)	41,609	44,829	39,792	1,69,967	2,68,058	2,13,951
Total value of Wood and Timber ..	2,26,786	3,41,075	1,05,278	18,81,071	13,50,708	10,91,735
Other Products of Wood and Timber ..	..	..	..	..	..	..

INDIAN FORESTER

FEBRUARY, 1940

BENGAL FLOODS

BY E. A. SMYTHIES

As a member of the Inter-Provincial Ganges Flood Committee, I was very interested in Mr. Ahmad's article on Bengal floods in the November *Indian Forester*, and have shown it to the Chairman of that Committee. Mr. Ahmad ascribes the principal cause of the recurring floods in Bengal, the loss and damage from which he describes so graphically, to the *jhuming* in the hills. Although that is probably a contributory cause, it is certainly not the only cause, and I very much doubt if it is even a (relatively) vital cause. The problem is far more widespread and on altogether a vaster scale than the action of a few hill tribes.

Let us consider in greater detail the first of the four river systems detailed by Mr. Ahmad, *i.e.*, the Ganges. The whole catchment area can be divided into several zones. On the left or north bank, we have Zone 1, the Himalayas and Zone 2, the Plains. These two zones are drained by a number of important tributaries, the Ganges itself, the Ramganga, the Sarda, the Kuriala or Gogra, the Gandak, the Bagmati, the Kosi, the Arun, the Teesta and a host of smaller tributaries. On the right or South (and West) bank, we have a further part of Zone 1 and Zone 2—drained by the Jumna, and also Zone 3 the Central India hills and plateaux, and Zone 4 the south part of the Gangetic Plain, drained by the Chambal, the Betwa, the Sone and other tributaries.

Consider Zone 1, the Himalayas, from the Punjab Hill States of Sirmur, Jubal and others, through (British India) Jaunsar-Bawar, the independent State of Tehri-Garhwal (British India), Kumaun, the independent Kingdom of Nepal (British India), Darjeeling, to the independent State of Sikkim. A glance at the map will show that the total area in British India (Darjeeling,

Kumaun and Jaunsar) is a very small fraction of the whole zone. Over the rest, neither the Government of India nor the Provincial Governments have any authority or control, and over the bulk of the zone we know there is no properly organised forest protection or conservancy of natural vegetation, without which it is axiomatic that the extension of floods and the velocity of erosion must get steadily and even rapidly worse. That is undoubtedly one of the fundamental factors in the problem—of far greater importance than *jhuming* in Bengal or Assam—and it appears almost insoluble.

Consider again Zones 2 and 4. I have no figures for Bihar and Bengal, but I can give some figures for the U. P. There are about 20,000 to 25,000 square miles of uncultivated waste lands in the plains districts of the U. P., the chief types being alkali *usar* plains and ravines formed by gully erosion in the alluvium, both types being symptoms of soil decay and destruction. These waste lands bring in little or no revenue to the state or income to the zamindar; no one, therefore, takes any interest in them or thinks of their protection. The bulk of the 40 million domestic animals in the U. P. roam over them, usually searching vainly for something to eat. The natural vegetation, which is Nature's own protection against floods and erosion, has little or no chance to survive and function. The ground is trampled hard and becomes impervious to percolation of rainfall. Some faint idea of the erosion which has taken place already can be obtained from a consideration of the ravine tract in the Jumna-Chambal area, which occupies only a very small proportion of the whole zone. It has been calculated that the soil removed from the Jumna-Chambal ravines is not less than 15×10^9 tons. Put in another way, this represents a stream of soil, flowing without stopping day or night, winter or summer, giving 12 cusecs (or $\frac{1}{2}$ ton per second) for the past 1,000 years!

Where has this inconceivable quantity gone to? Some presumably to the sea, but quite a lot must, I imagine, have been deposited in the lower reaches of the Ganges in Bihar and Bengal, choking up the river channels, raising the levels of the bed, reducing the amount of flood water that can flow in the channels,

and thus adversely affecting the river regime. And if tens of thousands of millions of tons have been washed down from this small corner of the Gangetic Basin, what is the total amount over the whole?

This is the second fundamental factor in the problem, and again it is extremely difficult to find any practical solution. It is easy enough to suggest that all waste lands should be protected from over-grazing, but who will do the protection, and where will the unfortunate domestic animals then go? The U. P. Usar and Waste Lands Reclamation Committee have been struggling with the problem for the last ten months.

Turning to Zone 3, beyond the fact that the bulk of the Gangetic catchment area in the central plateau lies in independent States of Central India, Rajputana and Orissa, I have little information. The problem here seems to be similar to, and as insoluble as, the problem over the bulk of Zone 1, in that the Central and Provincial Governments have no jurisdiction and can, therefore, take no direct action.

I have perhaps said enough to show that the flood problem in Bengal is a far bigger and more difficult problem than is indicated by Mr. Ahmad's interesting article, and that localised *jhuming* is only a comparatively small factor, at any rate for the Ganges Basin. It is certainly very unfortunate for Bengal that she should suffer so through the misuse of land in provinces and independent states far outside her borders, but this is a world-wide phenomenon, as that most interesting book, "The Rape of the Earth," clearly establishes. And as decade follows decade, the present indications certainly suggest that conditions in Bengal will tend to get worse, as more and more silt is deposited in her choked up rivers, and simultaneously, greater volumes of water try to rush down from the barren lands and denuded upper catchment areas.

Mr. Ahmad mentions "rumours of a Ganges River Commission." The actual position is that an inter-provincial conference was held last cold weather (following the terrible floods in the Gogra) which recommended the creation of an interim Ganges Flood Committee (pending the creation of the Ganges River Commission). This interim Committee has been appointed, and includes the Chief Conservator of Forests, United Provinces, so that

the forest point of view is represented. This Committee and the Commission that may follow later, have a vital problem to tackle, which, to my mind, *must* be solved for the welfare of the millions that inhabit the Gangetic plain, and which, simultaneously, appears to be practically insoluble on an adequate scale. If no adequate solution is found, Nature will, in due course, presumably apply her own drastic solution, *i.e.*, extensive depopulation, a solution she has applied more than once in the world's past history (*e.g.*, Babylon, North Africa, etc.), and is threatening to apply on an extensive scale at the present time in many parts of Africa, America, Asia and Australia. At the risk of writing a Jeremiad, I must record that I believe that the Gangetic Plain and Basin is one of the areas so threatened, for a country, where misuse of land is widespread and rampant, cannot indefinitely support an ever-increasing human and animal population.

FIRE PROTECTION IN HIGH HILL FORESTS

By N. G. Pring and Allah Bakhsh

PART I

The region referred to lies within the high hills and extends from the Tons river through the Punjab Hill States Agency, Siraj Mandi and Kulu to Chamba. The zone between elevations of 5,000 feet and 9,000 feet includes some of the finest forest estates in India and is of immense catchment value. A region with a similar forest flora extends from Patriata through Murree, along the Gallis of Hazara and over large portions of the Kunhar (Kagan) and Siran catchments. *Kail* (Pinus excelsa) occurs throughout this zone and to a small extent *Chir* (Pinus longifolia) in its lower limits. These intensely inflammable species are the prime cause of the fire hazard. Rainfall and snowfall vary according to elevation and locality. A wet cold winter is followed after a brief spring by a dry, hot season until the wet monsoon arrives in July. This is followed by a dry, cold season which lasts until the advent of winter rain or snow. The wet monsoon does not penetrate the higher reaches of the Sutlej, Chenab and Kunhar rivers. Coniferous forests extend far into the high level dry zones where the chief

climatic features are snowfall and dew. Late autumn fires are not uncommon, but the period of chief fire danger is the dry summer season and the hazard is greatly augmented by the late arrival of the summer or winter rains. When these fail, our forests become dry as tinder and even the normally damp high elevation fir forest becomes intensely inflammable.

Fire was primitive man's earliest weapon and one that gave him ascendency over beasts and enabled him to cultivate and pasture regions where the jungle would otherwise reign supreme. To-day in some of the wet zones of India extensive areas of jungle are fired so that the land may be tilled. From extensive areas of abandoned cultivation throughout the coniferous belt of the Eastern Punjab, it would appear that shifting cultivation was practised in many of our forests until fairly recent times. Firing by design or by accident has certainly resulted in succession in many cases. An excellent example is afforded by the forests above Pulga in the Parbatti Valley. In this very wet region *kail* invaded the typical fir zones, but as the result of more than half a century's fire protection the forest is now reverting to its original type. Eighty years of fire protection in the Simla municipal forests have resulted in the downward retreat of *Chir* pine from slopes that are now covered by deodar, oak and *kail*. We do indeed frequently use fire not only to reduce the fire hazard by burning débris but incidentally to perfect soil conditions for the species required and to prevent undesired succession. The search for pasture has caused the greatest incidence of incendiarism, whereever the resident and nomadic graziers compete.

Let us look back a century and picture the high hill regions as they then were in order to appreciate the results of fire conservancy from all points of view. The average village, with its surrounding cultivation, woods and grazing grounds, has probably changed but little in outward appearance. An abundance of timber, pastures and crops combined to form an easy existence: yet at the same time, wars, general lack of security and disease kept the population well below the economic saturation limit. During the first half of the nineteenth century there occurred a series of wars, commencing with the Gurkha invasion, which completely

changed the complexion of affairs. North of the Sutlej the Gurkhas were expelled by the Sikhs and south of the Sutlej by the East India Company. The Sikhs and the British extended their influence into these hill tracts. This achievement established a comparative security and a number of timber traders cut down large areas of accessible forest before the need for conservation was sufficiently appreciated. In Kulu these depredations are reported to have occurred before the British entered the Punjab. In the hill States they continued for a considerable period, until forest conservancy rules were effectively enforced towards the close of the last century. The Forest Department saved the local populace from economic destruction and safeguarded the water supply of the Punjab. Under an autocracy, the high hill villager had been left for centuries free to pluck the super-abundance of the forest while housing and husbandry were simple matters. The psychological results of a democratic bureaucracy were, however, by no means all favourable to forest conservation. The greatest care was taken to safeguard the villagers' rights. But their ignorance and occasional cases of mismanagement led to a certain amount of discontent. In particular the very necessary general restrictions with regard to grazing were resented and the problem was aggravated by the increase of local and nomadic herds, due to general prosperity and security. A peasantry, deriving enormous benefits from the Forest Department and, therefore, generally contented, was liable to become discontented in times of stress, and incendiarism was an all-too-simple means of vindicating their real or imaginary grievances.

The worst outbreak of incendiarism occurred in 1921 when a combination of factors, including a severe winter drought and political agitation, caused a wave of incendiarism which spread through the Himalayas from the Western U. P. to the Eastern Punjab. In the Kulu Tehsil, some 66,000 acres of demarcated forest were burnt and many pine and mixed pine woods were destroyed. Owing to the severity of the drought, some of the forest fires burnt for more than a week and spread right into the fir zone. Most of the Simla Hill States suffered badly. Subsequently the most serious case of incendiarism occurred in the Pabar Valley of Bashahr States during the winter of 1930-31 after a long autumn drought.

Kail crop burnt in 1930 fire. The area was not thinned and damage was great on account of congestion. Debris on the ground is mainly from dead trees which fell down after the fire, after the roots had rotted. In the event of a summer fire, is there any chance of survival of such crops? C. 45(a)i near Sungri.

Although literacy, mutual understanding and better management are now since long at work to uproot from the villagers' minds the incentive of this most hideous practice, yet fire hazard in the high hills is a problem of the first magnitude and if forestry is to make headway in these hills, we must find a sure solution for the fire danger. A close examination shows that the worst damage has occurred in *kail* forests. Spruce and fir forests, although growing in cooler altitudes, did not escape. As far as deodar crops are concerned, the damage is much less on account of its bark being thicker and rougher than that of *kail*. Although young plantations were seriously injured, the older crops, except in rare cases where probably the débris was so heavy that all trees in a patch were burnt, have survived. Also the forest floor under deodar is cleaner and there are fewer weeds than under *kail* canopy. The leaf layer under deodar is much more compact and consequently fire does not burn so briskly as in the case of *kail*. In some of the plantations where fire blanks were planted up, however, deodar is not flourishing. This is a greater reason why in a locality like Lower Bashahr, where *kail* is the principal tree, we should do everything possible to pilot through a crop of *kail* to maturity undamaged by fire. In certain forests through which severe fires had passed, undamaged *kail* trees were found standing in between severely damaged *kail* stands. Attention was directed to the study of conditions under which *kail* escaped damage from a severe summer fire. Observations were mainly concentrated on *kail* and deodar and burning experiments were made chiefly on *kail* in the hope that, in course of time, experience gained could, with necessary modifications, be applied to fir and spruce forests which are not extensively worked and are of much less economic value at the present time. A twofold object was kept in view in working out the details of fire protection. Firstly, to try to keep out the fires; and secondly, to bring the forest to such a condition that in case fires enter, minimum damage will be caused. Let us, therefore, examine the characteristic features of the disastrous fires of 1921 and 1930 which were typical incendiary fires.

The 1921 fires raged over most of the forests and it is very rare to find areas where the fires did not go. Examination of the forests shows that in certain places stands were badly burnt, in

others they were only partly touched, while yet in some others, they suffered little or no damage at all. Even the worst fires have not killed complete blocks of forests outright. The damage varies directly with age and density of stand and the quantity of refuse present at the time of fire. Only in rare cases were whole stands completely killed and these are small in extent. There is local evidence available to prove that heavy damage in the above fires, *e.g.*, at Larot, took place as a result of heavy exploitation débris left in the forests. Damage was also heavy on exposed spurs, but much less on moderate slopes and where refuse was not heavy. In the 1921 (summer) fire damage was great in young regeneration and pole crops but less where refuse wood and pine needles had been removed. In the 1930 (winter) fire, damage in older crops was insignificant and the area burnt in each forest was comparatively small.

Accidental fires also occur frequently and the main causes are probably lightning and falling of rocks. The writers cannot quote an authentic case of lightning causing a forest fire in their experience, but the disastrous fire in Blach Water Canyon, fully recorded in "American Forests" of November, 1937, in which 15 fire fighters died and many were seriously burned, was caused by lightning. A case of fire started by a fallen stone is recorded in the *Indian Forester* by Mr. Gotley and the writers know of three similar cases. It is probable that the vast majority of accidental fires are started by carelessness: carelessness that is criminal considering the damage caused and the great hardship to those engaged in fighting the fire or who suffer through the after-effects. While we shall never be able to preclude the accidental fire, we can with control measures and with the help of the local inhabitants reduce the fire hazard. The following are some recent examples of accidental fires:

February 1936.—Rantu forest—an open *kail* crop, 16 inches diameter with heavy undergrowth. No damage done except that trees burnt in the 1921 fires caught fire again.

March 1936.—Compartment 83 (*c*) (*i*) *kail* crop, average diameter 5 inches with a large number of saplings two to three inches in diameter and no débris in the area. Dry lower branches

of bigger saplings burnt the suppressed saplings, pointing to necessity for cleaning and proper spacing.

June, 1934.—Downhill accidental fire. Compartment No. 6 Nagkelo, *kail* crop 15 to 18 inches diameter. Dry fuel wood and leaf layer removed by villagers. Range Officer reported no damage. Close examination in 1937 showed in some cases uphill faces of some trees close to the ground, where leaves and brushwood accumulate, were damaged. This side is protected from wind and whatever débris there is continues to burn for some time showing that presence of débris and duration of burn alone cause damage.

May, 1937.—Uphill fire. Compartment 83 (*b*) (*iii*) *kail* pole crop with sapling patches thinned before the fire. Damage confined to trees standing close to heavy débris and trees previously damaged in the 1921 fires. Sapling crops, where recently cut saplings were left on the ground, were severely damaged. Very close to this area dense unthinned pole and sapling crops were completely burnt in an unreserved forest.

A study of the causes of forest fires needs a study of human nature in individuals and among communities. We must also clearly distinguish between the isolated malicious fires and general incendiarism. The former are localised and are the outcome of narrow personal malice. The latter are extensive and are an expression of the common will of the people with a common purpose in the background, always actuated by a sense of personal loss or gain. Both seek an opportunity most suitable for the accomplishment of their object and when conditions are favourable one may lead to the other. So long as human nature does not change isolated malicious fires will occur. It is the general incendiary fires that are most damaging and they must receive the greatest attention. Incendiarism among a discontented country-side may ruin forestry altogether, and the soundest way of eliminating the fire hazard must be the removal of sources of discontent and gaining the confidence of the people. Granting that we cannot eliminate the odd criminal fanatic and that there are bound to be a number of unreasonable grousers in a community, the question is: Are the communities largely dependent upon our forests for their contented existence, and, if not, what are the causes of their griev-

ances? The answer to the first part of the question is *definitely no* and this seems to be startlingly demonstrated by the recent Punjab Forest Committee's Report. The answer to the latter part is therefore to be sought for.

During the past 60 years systematic forest conservancy has gradually brought large forest lands under tree growth of normal density and good pasture lands are imperceptibly disappearing. Although large areas of forests are open to grazing and grass cutting, the quantity of fodder available is far less than it used to be for the annually increasing number of cattle and the villagers, with some justification, attribute part of this shortage to the activities of the Forest Department. To obtain more grass they must reduce forest areas and when they are hard pressed for grazing and grass-lands they resort to burning and when they are desperate nothing can stop them. Political unrest offers a safe and favourable opportunity for burning the forests for use as pastures. Under such favourable circumstances fires started in one area are copied in the neighbouring districts until they cover extensive forest tracts. Incendiarism, therefore, is generally nothing more than a wish of the people to get rid of as much of the forest area as possible to provide for better pasture lands. Their forefathers did the same in the remote past whenever natural forest encroached on their pasture lands. Such general incendiarism is not usually an expression of a protest against the dealings of the subordinate staff, but is definitely directed against the efforts of the Forest Department for better forest conservancy. Where pastures are decreasing, the number of sheep must decrease, thus reducing an easy source of excellent manure and of extra income for the villagers. They cannot, however, similarly reduce the number of bullocks and cows as they must keep a certain number to carry on agriculture. The villagers have, therefore, to put more of their land under fodder and consequently less under grain and money crops. That is one way in which forest conservancy pinches the villager. But, unfortunately, in the rapid increase of population we have a problem which baffles solution. Increase of population and consequent demand for more land is gradually bringing more areas of grazing lands under cultivation and pressure is thus increasing both on agricultural lands and forest areas.

The villagers have a firm, deep-rooted belief that burning promotes growth of profuse, green, tender and juicy grass in spring and to keep their cattle in condition, they must have it and nothing else but a good burn will provide it. That is why every village must have a *ghasni* and where *ghasni* is available they invariably burn it in winter. It is also true that grass growing under heavy canopy is less nourishing and the cows fed on such grass do not yield good milk. Similarly, the milk production in cows is reduced if they eat *kail* leaves with grass while grazing. Therefore, to save our forests from incendiarism we must actually interest ourselves in exploring all avenues to meet the requirements of villagers in the form of fodder, fuel and timber. Village forests, where they have not already disappeared or irrevocably deteriorated, are capable of improvement, though in many of them land is being brought under cultivation and tree growth is disappearing. They are either too congested or too open to produce sufficient timber or to conserve sufficient moisture for the growth of grass. In order to conserve them and to derive the maximum benefit from them, it is essential that village forests should be brought under proper management and run under proper working schemes chiefly for fodder production from grasses and broad-leaved trees. Where the village forests are inadequate and the population is dense and if in addition the canopy in Government forests in the neighbourhood is so closed up that it will permit of little growth of grass, the villagers are likely to continue to burn the forests.

The writers believe that the time has come to alter our system of management so that undemarcated village forests and those portions of our demarcated forests near villages where rights are heavy, are brought under a system of village management on the lines drawn up by Mr. Glover for part of Kangra District. A closer association between the community and the Forest Department would go a very long way in reducing grievances and, therefore, in reducing our most serious menace—the fire hazard. Under a system of co-operative mangement we should be able to tackle the pasturage problem. We could, by means of a better use of land, increase and improve the amount and quality of pasture in our forests and, on the other hand, we could, through propaganda and demonstration, induce right holders themselves to limit the grazing

stock according to the grazing incidence, either by stall-feeding or by the reduction of stock. The villagers possess a wealth of local knowledge which they would share had they a greater stake in the forest claim and not the least among the mutual advantages of joint management under the guidance of the Forest Department would be the reduction of the fire hazard. Obviously, we cannot everywhere at once introduce co-operative village management. Such a policy may not be feasible for many years to come in certain tracts. In any case it would, perhaps, be as well to be guided by experience gained in Kangra and in the meantime to study similar systems in other countries. A special scheme for the partial opening to cattle of closures during droughts and famine is worth considering. The measure of relief would certainly be appreciated and the presence of cattle would afford the greatest security against fire.

It is also for consideration if upper zones, *viz.*, 10,000 feet and above, in particular southern aspects, should not be managed entirely as pasture lands. This will relieve pressure on lower altitudes, as sheep and dry cows could find plenty of grazing there during summer. At present these heights do not carry forest growth oñ any economic value. The existence of high-level fir and broad-leaved species at these levels, on the other hand, prevents the growth of grass.

Rights should occupy more space in the working plan than is at present devoted to them. They should deal in full detail with the latest human and cattle population and their exact seasonal requirements, laying down the manner in which provision will be made to meet them, taking into full consideration the supply, if any, available from agricultural lands and village forests. Whereever the people have few recorded rights and where they have been granted some concessions, as in Kotgarh Ilaqa (Simla District) and in Kotkhai, we have a much easier control than elsewhere. They know that if they do not behave properly the concessions will be withdrawn. Kalala and Nagkelo forests are good examples of this. In these forests the villagers have been granted some concessions, and they are always afraid of these being withdrawn. The result is that there was less incendiarism in these areas during 1921 and 1930. If we could give new concessions, say for grass cutting

and grazing or sheep grazing, where no such rights exist, the withdrawal of such concessions could be used as a penal measure against incendiarism. As such, concessions given to the local people should be conditional and subject to good behaviour; and whenever incendiarism on a large scale takes place, the concessions should be withdrawn as a punitive measure. Throughout most of our danger zones we have a fairly heavy neighbouring population whose duty it should be to extinguish fire and concessions should depend on the fulfilment of that duty. For good administration, a system of rewards and punishments is also very essential. In Bashahr State after the 1921 incendiary fires, no punishments were inflicted and the 1930 fires followed soon But after the 1930 fires some rewards were given and fines were inflicted on a large scale by the State to prevent a recurrence with good results. In Kulu, as the result of action taken a few years ago, against right holders who failed to turn out, several fires of 1938 were each attended by hundreds of villagers, and fires that would have certainly extended over a hundred acres or more were confined to an acre or two. The incendiarist deserves the heaviest penalty inflictable; it is in the interest of the local community and also of the far greater numbers who dwell in the plains and depend on the water supply afforded by the forest, that he be brought to book and punished severely for his crime. The 1922 Forest Conference recommended that punitive closures when properly enforced were effective but such a procedure tends to increase inflammable material. As an alternative a system of imposing punitive grazing fees was recommended. Sections 26 (3) and 33 (2) of the Indian Forest Act of 1927, which provide for suspension of rights in the reserved and protected forests, respectively, in case of fires, have not sufficiently been made use of. Whenever an offender cannot be traced in serious cases of incendiarism, it should be a rule to punish the community as a whole under the above sections, or alternatively make the concessions or rights more expensive for them by charging fees

(To be continued.)

THE INDIAN FOREST COLLEGE SCIENCE SOCIETY

BY G. N. SINGH (*Secretary*)

The Society was inaugurated during the rains term of 1939 by our Principal, Mr. E. C. Mobbs, I.F.S., who was unanimously elected as its President. Mr. J. L. Harrison, I.F.S., was elected as Vice-President and Messrs N. Bhargava (Kotah State) and G. N. Singh (United Provinces), Vice-President and Secretary respectively.

Meetings of the Society are held once a week after dinner in the Mess Common Room when the College is in residence at New Forest. Officers of the Forest Research Institute and the Indian Forest Ranger College or any other forest officers who may be in Dehra Dun are cordially invited to attend.

The following were the subjects of the papers read at meetings held during July and August, 1939:

July 13th—*Agricultural Chemistry and the Indian Farmer,* by B. N. Prasad.

July 24th—*Forest Photography,* by Mr. M. V. Laurie.

July 31st—*Strange Plants,* by T. N. Srivastava.

August 10th—*Radio and Television,* by Sami Ahmad.

August 17th—*Science and Religion,* by G. N. Singh, K. L. Lahiri and M. H. Khan.

August 21st—*Birds of the Indian Forest,* by Mr. Salim Ali.

Mr. Salim Ali read his paper in the College where occasional big meetings are held to utilise the epidiascope and to provide sufficient seating accommodation, etc.

The following is a brief summary of the papers:

AGRICULTURAL CHEMISTRY AND THE INDIAN FARMER

By B. N. Prasad, B.SC. (*Hons.*), *of Bihar.*

Agricultural Chemistry is of very great importance to the Indian farmer. An agricultural chemist can help a farmer in almost all his operations, starting from the purchase of land to the harvesting and sowing of the crop. He can gauge the value of any land that the cultivator may propose to buy, decide for him the most suited crop for the land, help him in bringing the field into

the right condition for the species, advise him on the vital subject of manures, particularly regarding their preparation and use, fix for him the best time-table for the various agricultural operations and at the same time their degree and tell him the exact time and way of harvesting the crop. Apart from these general items the agricultural chemist tackles the problems of reclamation of *usar* (alkaline unproductive) land, rotation of crops, supply of fodder in quality and quantity and such other special problems as curing of tobacco leaves, insecticides and fungicides.

In spite of such a vital connection between the agricultural chemist and the Indian farmer, the relation between them has often been an unhappy one. There is sometimes a lot of "red-tape-ism" in the Agricultural Departments. Most of the results of the researches remain in the laboratory or in the scientific journals simply due to lack of propaganda. Furthermore, Indian farmers are too poor and uneducated to enjoy all the benefits that the agricultural chemist promises them. Hence the real remedy lies in mass education and thereafter real propaganda coupled with better relations between the chemist and the farmer.

FOREST PHOTOGRAPHY

By Mr. M. V. Laurie, I.F.S., *Silviculturist,* F.R.I.

Mr. Laurie brought with him a large variety of cameras of all makes, sizes and qualities, and discussed their relative merits for forest photography. The $2\frac{1}{2} \times 3\frac{1}{2}$-inch and the $\frac{1}{4}$-plate sizes were favoured for general use and, while pointing out that good work can be obtained with the cheapest of cameras, he recommended as good a camera as one can afford, as the possibilities of the better makes are so much greater for the difficult subjects forest photography often presents.

The art of photography was then discussed under the heads focussing, exposure, filters and finishing. Depth of focus and size of aperture to be used were explained. Emphasising the necessity of correct exposure, various types of exposure metres were shown and explained—notably the card, sensitive paper and photo-electric types.

An array of colour filters was also shown and their uses explained and, to conclude with, a number of very useful general

hints given. A collection of photos was passed round and subsequently placed in the College Common Room to illustrate various points of good or faulty photography in detail. Explanations of these had been written by Mr. Laurie on their backs.

Keen photographers had numerous questions to ask and the novices in photography were made much keener by Mr. Laurie's very interesting talk.

STRANGE PLANTS

By T. N. Srivastava, M.SC. *(Luck.) of U. P.*

After explaining what he meant by strange plants, the speaker reviewed the whole plant kingdom, laying stress on the various remarkable features of the different plant types. Very simple plants, for example, Euglena, Pleurococcus, Chlamydomonas, etc., were shown to possess the strange power of utilising nature in a perfect way. Several giant plants of the Phæophyceæ, *e.g., Macrocystis, Necrocystis* and *Postelsia* were described and their dimensions given. Among the liverworts and Jungermanniales it was observed that they could be preserved for a long time in the folds of paper. Hygroscopic movements of *Selaginella bryopteris* and the special leaves of *Welwitschia or the Tamboa* plant were also mentioned.

Insectivorous plants like *Drosera,* Butterwort, *Nepenthes,* the Bladderwort or *Utricularia,* Venus' Flytrap and *Saracenia* were next dealt with. Among parasites *Cassytha, Christisonia,* or *Balanophora, Loranthus* and mistletoe were described. *Saprophytes* like *Monotropa* (Bird's nest) and *Neothia* were also described. *Mimosa pudica,* the Touch-me-not, and *Desmodium gyrans,* the telegraph plant, were shown to possess peculiar physiological movements. *Cassia tora* was an example of sleep or nyctinastic movements.

Coming to the giant *angiosperms* the speaker described *Sequoias, Eucalyptus* and the giant water lily of the amazon—*Victoria regia.* Various peculiar methods of pollination with strange mechanisms to effect cross fertilisation were then described and mention was made of the remarkable periodicity in flowering of bamboos, *Strobilanthes,* etc.

Mimicry in plants was next dealt with and several plants, such as the cobra plant, etc., were shown to possess resemblances to animals by warning coloration or other means.

The use of water stored in plants like Travellers' Palm and *Echinocactus* by thirsty travellers, and among harmful plants the Nettle, *Hologarna*, *Nothopegia*, etc., were mentioned.

RADIO AND TELEVISION

By Sami Ahmad, B.SC. (*Hons.*) *of Bihar*

The paper started with a brief history of the subject, beginning with Kelvin's theoretical investigation of the periodic discharge of a condenser, Maxwell's electromagnetic theory of light and their correlation by Hertz on a practical basis. The speaker explained Marconi's improvements of Hertz's method and his success in transmitting the letter "S" across the Atlantic A description of modern methods of transmission and reception by means of the thermionic valve, invented by Fleming, based on Edison's discovery of Electron Emission from hot bodies, was then given.

Lastly, the use of radio as a means of communication and in fire fighting in the forest was dealt with, and photographs of the transmitters and receivers in use in the U.S.A. were shown and explained.

The whole subject was dealt with in a very able and lucid manner and Mr. Ahmad showed himself to be a good speaker. It was a little disappointing, however, to find that he had no suggestion for the increased use of wireless in Indian forestry, his chief objection being the cost of the transmitting and receiving equipment that would be required.

SCIENCE AND RELIGION

By

G. N. Singh, M.SC. *of U. P., K. L. Lahiri*, B.SC. (*Hons.*) *of Bengal and M. H. Khan*, B.SC., *of Kashmir.*

Three papers were read representing the Christian, Hindu and Mohammadan view points.

Mr. Singh started off by showing how the idea of God had arisen as a product of biological evolution since the human type of mind first came into existence. The term "God" was shown to

have an important scientific connotation. The present stagnation of religion was regretted, but he hoped it might be remedied if as had happened before in biological evolution again and again, the old forms became extinct or subordinate and a new dominant type developed along quite fresh lines. The question of faith and the subconscious was dealt with in relation to psychology.

Later, it was pointed out that plasticity was needed in religion, meaning thereby tolerance and reduction in fixity of ritual convention, dogma and clericalism.

Reading a few words on *public worship and community* religion, the speaker brought his paper to an end, ultimately making a compromise between religion and science and observing that the "Next great task of science was to create a religion for humanity."

Mr. Lahiri first discussed the importance of the subject in the present day, the opinions of the various authors on the subject and their relation to one another.

The evolution of mind was next described. It was deduced that religion is a channel to guide the moral character of a community. The deduction was supported by showing the similarities in the gospels and the holy books of all religions. Finally, coming to the Hindu religion, the holy books were discussed on a scientific basis. He also spoke on psychology and idolatry in Hinduism. In conclusion, he expressed a definite opinion in favour of having a religious domain in our modern scientific age. The paper was more an account of Hinduism as something quite distinct from religion than a discussion on the interaction of Hinduism and modern science and one was still left wondering what was the attitude of the orthodox Hindu to modern science and of the scientist to orthodox Hinduism.

Mr. Khan was certainly more definite in his ideas. He commenced by giving a short history of the origin of religions, saying that they had cropped up as and when necessity was felt to reform a society indulging in corrupt practices. The genuine mission of religion cannot, therefore, be overestimated so long as it confines itself to social reform and is flexible in its application. But it got a set-back when the preaching classes abused their position and remaining oblivious to the intellectual development of

man, moulded the doctrines to suit their selfish motives. They made them rigid, with mistrust and corruption as the consequences.

Also with the lapse of time the theologians who were used to dogmas vehemently resented the questioning of their dogmas, Persecutions followed, and people sceptical about the dictates of the priests were subjected to inhuman atrocities. This heralded the advent of science and the decline of the hold of religion on man.

The blunt attitude of theologians could not long withstand the onslaught of a scientific outlook which had now practically ousted religious superstition. In civilised countries like Turkey and Russia religion had only a theoretical importance and it was at the mercy of science.

Further, the speaker said that fortunately for the priests, scientists like Eddington and Jeans have trifled with the idea of God—the keystone of nearly all the religions. By inventing their own gods they had indirectly admitted their ignorance about the behaviour of the atom which had goaded them to this invention. The religious conception of God, based as it is on pure and untarnished ignorance, could no longer appeal to the modern mind. But it did not detract from the poor prelates' belief in God, even though his omnipotent God had been reduced to a puppet in the hands of Eddington and Jeans. In his vanquished state what he feels concerned over was that somebody besides himself did say "There is a God."

Mr. Khan ended by saying that religion to-day was a farce incarnate. So far as the theory went it was all well and good, but as practised, it was dogmatic, advocated the mysterious and was sentimental. But dogmas, sentiment and mystery had no place in science which was logical, dispassionate and had the unravelling of mysteries as its aim.

BIRDS AND FORESTS

By Mr. Salim Ali.

Mr. Salim Ali commenced his very interesting paper by showing the absorbing interest of bird watching and recommended it as a hobby to forest officers to prevent boredom owing to the

absence of urban luxuries. He paid a tribute to certain forest officers, notably the two Osmastons, B.B. & A.E., and T.R.D. Bell, for their ornithological researches.

He then described the importance of birds to forests under three heads:

1. Fertilisation of flowers.
2. Seed dispersal.
3. Destruction of pests.

Under the first he explained, with the help of photographs and drawings shown with the College epidiascope, the cross fertilisation of *Semal, Erythrina* and *Loranthus* by various species of birds.

Under the second the methods of seed dispersal of *Loranthus, sandal* and other trees were explained. Lastly, he emphasized the importance of birds in the destruction of pests, notably the *sal*-borer, *Haplocerambyx spinicornis*, by the scaly-bellied wood-pecker, and various rodents by owls and other birds.

TUBERCULOSIS IN ELEPHANTS

By S. D. Devadoss Pillai, G. M. V. C.,

Inspector of Livestock, Calicut.

I am a graduate of the Madras Veterinary College and entered service in the Madras Forest Department in 1915. The most important work for me is the care and treatment of Departmental elephants and to assist in elephant capturing operations.

The first capture we had since I joined the service was in September, 1915, at Mount Stuart in Coimbatore District and it was a beautiful five-year-old cow calf. She was five feet nine inches in height at the time of capture. She was christened "Ganga" by the late Conservator, Mr. H. F. A. Wood. As days passed, she grew into a beautiful and strong calf. She began to get her training in riding, baggage carrying and departmental dragging of logs. She turned out to be a good, all-round elephant with the result that she was popularly known as "Wood's Ganga." After a few years, she was transferred to Mudumalai in the Nilgiris. At Mudumalai, she was known as the "Mudumalai Mail" on account

of the terrible speed of her walk or shuffle. On an average, she used to go over five miles an hour easily. She lived till the age of 29 years and then died. Within this period, she gave birth to three calves, *viz.*, "Indrani," "Goutama" and "Saraswathy." The circumstances under which she met with a premature death is the subject-matter of this article and is briefly described in the following paras:

This animal was first noticed going down in condition in February, 1939. In spite of very careful medical aid given, there was no improvement at all and the animal began to show some liver disorders. Then progressive emaciation and loss of flesh were noticed. On auscultation of the lungs, it was observed that the lungs were affected and there was a wheezing sound at about the lower third of the chest. In addition, there was also a slight increased movement of the abdomen during breathing. On percussion, dullness was distinct. Her heart action was more than normal. With the slightest exertion she began to show symptoms of fatigue. There was constant dripping of watery discharge from the trunk. She had no aversion to take her usual food, both natural and artificial. Her dung was, however, constipated and urine high-coloured. Her temperature was taken on four consecutive days and it was as follows:

Date		*Morning*	*Evening*
3-6-1939	...	...	98.6° F.
4-6-1939	...	97.6° F	98.6° F.
5-6-1939	...	97.6 F	100° F.
6 6 1939	...	95.8° F	97° F.

This made me suspect that she might be suffering from tuberculosis. During this period, she never slept lying down but was having a restless sleep standing with all her legs propped out.

On 7-6-1939, she had a subnormal temperature, *i.e.*, 95° F., with an intermittent pulse, distressed breathing, restlessness and salivation. She refused all food and at about 9-45 a.m., she fell down

and died. A post-mortem examination was conducted and the result was as follows:

Both the lungs were found to be highly congested, thick and studded with tubercle nodules and did not collapse. Sections of the lungs were full of large and small greyish tubercle nodules which were moist but did not crepitate on pressure. Necrosis, caseation and calcification were prominent in both the lungs. Lung pieces were heavy and sank in water.

I attributed the cause of death of the animal to pneumonia due to tuberculosis of the lungs. Pus smears and sections were taken and sent to the Madras Veterinary College for examination. In the pus smears, no acid-fast organisms could be detected and this was the result intimated to me. I could not diagnose anything but tuberculosis. But a further communication from the Principal of the Madras Veterinary College, that the section of the lungs revealed a caseating broncho-pneumonia in which acid-fast bacilli, indistinguishable from mycobacterium tuberculosis, could be detected, relieved me of my anxiety. I was glad my diagnosis was a correct one.

This reveals the fact that elephants do suffer from tuberculosis although it is rare amongst them. Tuberculosis is a very virulent disease affecting the human system and claiming a large toll in human lives. But this is the first case in my experience of 24 years in the Forest Service in which an elephant has shown the acid-fast bacilli indistinguishable from mycobacterium tuberculosis of the human type. "Ganga," I believe, might have had the infection from contaminated food materials through some human agency.

Whether elephants in their wild state harbour tubercle bacilli is still a mystery. It is a common belief that in their natural state they do not suffer from this disease. There is probably some truth in this as they roam about in the vast expanse of thick forests under Nature's care and Nature's cure. Moreover, in a wild state, they have been found to be perfectly healthy and strong and thus not likely to be susceptible to this fatal disease.

THE STAPHYLINID BEETLES OF INDIA

THE FAUNA OF BRITISH INDIA—COLEOPTERA-STAPHYLINIDAE

Vol. IV, Parts i and ii.

BY MALCOLM CAMERON: LONDON, 1939, PP. I—XVIII, 1—410, 411—691, PLATES I—III, 143 TEXT-FIGURES, 1 MAP.

Price, Part i, 25 shillings, Part ii, 15 shillings.

Dr. Malcolm Cameron, who was Systematic Entomologist at the Forest Research Institute from December, 1920 to September, 1923, has completed his monograph of the staphylinid beetles of India. The first volume appeared in 1930 and the second and third volumes in the two following years. The fourth volume has just been issued in two parts and deals with the remaining sub-families, *Pseudoperthinæ* and *Aleocharinæ*.

Much of the material on which the monograph is based was collected by Dr. Cameron himself, but forest officers have also contributed very largely and consequently numerous new species have been named after them. The total number of species recorded from India, Burma and Ceylon is over 2,274, but, undoubtedly, there are many more new species to be found in regions which are still practically unworked.

To those who would like to take up the collection of a group of insects as a hobby this family offers many attractions. Staphylinid beetles are to be found in all kinds of environment and throughout the year; they are easily preserved and the mounted specimens take up very little space. The keys, descriptions and illustrations in the Fauna volumes afford the maximum help to the beginner and specialist alike. A complete set of the volumes costs five guineas and comprises 1,862 pages of text, 378 text-figures and 12 coloured plates.

C. F. C. B.

THE FAUNA OF BRITISH INDIA, NEMATODA
VOL. II

BY H. A. BAYLIS; LONDON, 1939, PP. I—XXVIII, 1—274,

1 MAP, 150 TEXT-FIGURES. PRICE 17S. 6D.

The first volume on the nematodes was published in 1936 and was reviewed in the *Indian Forester* for December, 1936, page 763. The present volume concludes the systematic account of the parasitic worms of the group in India, Ceylon and Burma.

A classified list of hosts with the nematodes recorded from them occupies 13 pages. Fifteen species are known to attack man, 17 the elephant; no bird is known to have more than eight species. Very little is known about the nematode parasites of insects and there is evidently a great deal of work to be done by collectors before the importance of these enemies of caterpillars and larvæ is adequately assessed.

C. F. C. B.

EXTRACTS

THE CULTIVATION OF CINCHONA IN INDIA

It appears probable that we shall soon be having a big development in the cultivation of cinchona in India. Towards the end of the year 1937 it may be recalled that the Imperial Council of Agricultural Research set on foot an enquiry into the prospects of cinchona cultivation in India and appointed Mr. A. Wilson, Deputy Director, Cinchona, Madras, to conduct the enquiry and also associated with him Dr. T. J. Mirchandani, Agricultural Chemist, Bihar, as Soil Chemist. The Report of these officers which has just been published as Mis. Bulletin No. 29 of the Council, goes fully into the subject, giving an account of the present situation and prospects and an equally interesting survey of the nature and extent of the efforts in the past It may not be generally known that India is already a fairly large producer of quinine from locally grown cinchona bark and that in the past it was producing much larger quantities. The present annual production is put down as some 70,000 lbs of quinine; until about the year 1880 she was a much larger producer, the estimated quantity of bark per year at that time being as much as 950,000 lbs. or an output of nearly two lakhs of pounds of quinine—facts which amply demonstrate that India has the soil and climate suitable for producing a large quantity of her requirements of the drug. This important factor, *viz.*, India's requirements, is estimated variously; the author estimates it at six lakhs of pounds; he also refers to other authorities who estimate it at 12½ lakhs of pounds or over twice the first estimate. This is further complicated by the fact that in reality India is consuming only 210,000 lbs. per year or only a third of the lesser of the above two estimates. An account is also given of the difficulties which the Government met with in disposing of their stocks; consumption fell from 80,000 to 60,000 lbs. even though prices became cheaper by 30 per cent. and the demand could not be increased even when the stock was offered for sale at a big sacrifice in price. Altogether we cannot help thinking that this matter of the quantity which India will absorb is decidedly obscure and needs to be clarified. We wish

also that a statement had been furnished to show the consumption per year for a period of, say, the last 10 or 15 years. Anyhow the Report takes 210,000 lbs. of quinine as the annual requirement; of this quantity local production supplies at present 70,000 lbs. and the remainder is imported. The immediate objective, therefore, is to grow enough cinchona in the country to produce this 140,000 lbs. of quinine that is now imported. The report further envisages the need for producing the much larger quantities referred to above and contain suggestions to that end also.

Land considered promising for cinchona cultivation in many parts of India, notably the planting districts of South India, Assam, Bengal and Orissa, and the Andaman Islands have been surveyed, soil analyses and profile studies made, and the requirements in this regard discussed. Altogether an area of some 38,000 acres has been specified as suitable and additional tracts have been indicated for further similar inspection, if a much larger production is contemplated, though for the planting programme of twelve years at the rate of 3,333 acres annually stated as required for the latter larger production, this 38,000 acres appears sufficient. Government planters and small holders are all suggested as suitable agencies for the growing of the plants. We may point out in this connection that no information to show what money return can be expected from the cultivation of cinchona is available in the report although this is an all-important factor, at least as far as the private planter is concerned, whether large or small. The cost of production is, however, given in detail; a statement of the prices paid for bark, or the unit prices that have ruled for the last ten years or so will have greatly added to the usefulness of the report. We should also like that analyses had been given of the soils of certain Annamalai estates where bark with a high quinine content of 11 per cent. was being produced, and likewise of the soils of the Tavoy plantations which are stated to have been a disastrous failure although the area was selected by one of the greatest experts in cinchona.

The species *ledgeriana* is the one recommended to be grown. It is gratifying to learn that 72 per cent. of the cinchona grown in India at present is *ledgeriana*, and that among these some extraordinarily good areas may be seen. The need for research is emphasised on the famous Java model and a strong plea put in

for a research station for isolating better performing strains of *ledgeriana,* for their multiplication as plants on their own roots or grafted on to *succirubra* stocks, for much nursery technique and so on. Such a station is in our opinion long overdue.

Much has been accomplished even as the result of grafting the *ledgeriana* on to the less exacting *succirubra* in Java, a comparatively easier line of work which, we are told, is being done with great facility by ordinary coolies trained for the work, at the rate of some 300 to 500 grafts per day for a set of two coolies; it should be possible to undertake this work at least straightway on the present Government plantations themselves. It is stated that it was attempted but was not persisted in. The point is further stressed that unless this better species and better yielding types among it are grown it will not be possible to reduce the cost of production. This cost of production will probably be the rock on which schemes of expansion and continuance will split: motives of self-sufficiency are not likely to stand the strain of the ever-present and insistent claims for economy, specially if large supplies of cheaper quinine should be available from Java or other foreign sources. The lines of expansion indicated in the report are cautious and sound; we hope suitable action will soon be taken to give effect to the recommendations. –A. K. Y. in *Current Science,* Vol. 8, No. 9, September, 1939.

SOME MISCONCEPTIONS ABOUT THE PULP AND PAPER TARIFF

BY A. R. BARBOUR, O.B.E.

Provided nothing untoward occurs in the meantime to interfere with the ordinary course of events, it is more than likely that a Tariff Board will be constituted at the end of 1940 or early in 1941 to examine once again the question whether and to what extent fiscal protection should be given to the paper industry. No doubt all the pros and cons will then be fully debated. In the meantime it may be of interest and may serve to clear the ground a little if some attempt is made to remove one or two very prevalent misconceptions which are apt to confuse issues and hinder discussion.

Object of the Paper Tariff.—One of these, strangely enough, relates to the "purpose" of the tariff on paper. Many people imagine that the object was the creation of a new industry—that of making pulp and paper from bamboo—and there is much to lend colour to this theory, but it is not correct. To think thus is to mistake means for ends. The development of bamboo is merely the means to the end and not the ultimate aim. It was necessary if the paper industry in India was ever to reach a position of economic freedom. Without it the industry might have become dependent upon other countries for its raw materials and eventually have sunk into the position of a mere "converting" industry. The Lancashire cotton industry, the paper mill industry and several others in Great Britain are doubtless striking examples of the value which this form of industry can attain, but a country possessing abundant resources of raw material would be naturally desirous of turning these to the most profitable account. Hence, according to the generally accepted interpretation of the conditions of "discriminating protection," a mere "converting" industry is not entitled to protection under that policy. The Indian paper industry had, therefore, to prove itself capable of adapting itself to the conditions governing the grant of protection.

In doing this the industry has developed a new paper-making material which, in future years, may become of inestimable value to the world's paper industry. But was that the object of the protective tariff? Was it not something more directly and closely identified with India's special conditions and requirements? What, then, was this ultimate aim? The answer is given in the clearest language by the Tariff Board which originally recommended protection in 1925. Their final words on the subject leave no doubt as to the true objective. They said:

> "The issue which the Government of India and the Legislature will have to decide is clear and well defined. If no assistance is given, it is probable that the manufacture of paper in India will cease, with a somewhat remote prospect of a revival when wood pulp has grown very dear. The question for decision, therefore, is whether it is worth while to keep the industry going at what, in all circumstances, is a moderate cost, or whether it must be left to its fate. For our own part we feel strongly that the disappearance of the industry at the moment when the use of bamboo opens up fresh avenues of development in the future would be very regrettable, and we believe that the proposals we have made are in the national interest."

Here we have no limiting or qualifying phraseology but a plain and unequivocal statement that the matter at issue is the life or death of the paper industry in India, with bamboo relegated to its true place as a means towards further development and not as an end *in itself*. To achieve this purpose the Board recommended a specific protective duty of one anna per pound on *certain classes of paper and this was imposed.*

No misconception as to the purpose of the tariff could have occurred had the *above-quoted final statement been the only* pronouncement of the Board or had it been remembered—

(*a*) that the Tariff Board was not constituted to consider or to support proposals for a new industry, and

(*b*) that its instructions were to examine the claims of the paper industry, and not those of a non-existent separate pulp industry, the manufacture of pulp being purely ancillary to the production of paper.

The Board was well aware that the claims it had to examine had, *in the first instance*, been put forward by the older mills whose representation to Government *had specifically drawn attention* to the fact that India was favourably circumstanced with regard to the development of "New" paper-making materials and had adduced this point as one of the grounds of their case. Unfortunately, no attempt was made by the Board to discuss the general question of the need for promoting paper-making in India or to appraise the importance and value of the industry to the country. Instead it looked more particularly at the respective claims of different sections of the industry, considering these solely in the light of the three main conditions laid down by the Fiscal Commission. Consequently, the findings of the Board centred mainly round the question of the raw material. If some of these conclusions were expressed in a manner adverse to the largest section of the industry, *it does not necessarily follow that in the* eyes of the Board the salvation of an old established Indian industry was of less consequence than the *development of a new paper*-making material. The Board may indeed not have made up its mind on this point, but, as we have shown, *it did not attempt to* shirk the real problem when it asked Government and the Legis

lature to decide the "clear and well-defined" issue—nothing other than the fate of the paper industry.

The Government Attitude.—If the Tariff Board put more weight on the question of making bamboo pulp than of saving the paper industry, such was certainly not the attitude of Government which had appointed the Board. The Government view was exemplified by the way in which it dealt with the Tariff Board's recommendations. It rejected the proposal to subsidise the Indian Paper Pulp Company on the ground that it would give that company "an advantage over its competitors." Speaking for the Government in the Legislative Assembly on 10th September, 1925, Sir Charles Innes said he hoped the House would "agree that in a matter of this kind the policy of Government should not discriminate unfairly between particular firms competing in an industry." He declared that the proposed import duties "would protect all mills alike" so that "all the mills which have invested money in this industry will compete on equal terms whether they are making paper from bamboo or from grass." He wound up his speech by quoting the Tariff Board's final pronouncement and telling the Assembly that Government wished to help the paper industry. On another occasion Sir Charles refused to allow the words "and grass" to be inserted in the title of the Act, saying that it was "not a matter of practical importance" and indicating that to do so would conflict with the findings of the Tariff Board. The debates made it clear, however, that Government did not follow the Tariff Board in its differentiation between one part of the industry and another, but preferred to look at the industry as a whole. In agreeing to protect the entire industry, its ultimate aim was to ensure the more economical and extensive manufacture of "Paper" in India, in order that the country as a whole should benefit.

Foolish Prejudices.—In 1934 the Bamboo Paper Industry (Protection) Act, with its delusive and discriminatory title, made its appearance from the Statute Book, the paper and pulp duties being now included in the Indian Tariff Act of that date. This change is welcome for it undoubtedly makes for a clearer understanding of the real position. Such an understanding is badly needed for the prejudices arising from the strictures of the 1925

Board still have a strong hold on the public mind, and even the spokesmen of Government have no hesitation in turning them to advantage when it suits their purpose. Too much is still heard of discriminatory phrases which have now little or no meaning. One of these is the parrot-cry that "the grass mills have no claim to protection," a statement which had its origin in the anxiety of the 1925 Board to emphasise its rigid adherence to the principles of "discriminating protection" and to stress the importance and value of bamboos. In the interests of India's industrial progress, no less than in that of the industry itself, it is time that the nature and origin of such prejudices should be recognised and the ground cleared for a truer appreciation of the importance of preserving and developing the paper making industry of India in all its branches if the country is eventually to become self-supporting in regard to one of the basic elements of modern civilisation.

It is true enough that in 1925 the grass mills did not, in the opinion of the Tariff Board, fulfil the conditions requisite to the grant of protection. But what, after all, were these "grass mills?" The term "grass mill" was a label applied to that section of the paper industry which was then producing most of India's paper and had borne the heavy burden of meeting the needs of the country during the troublous times of the War years and the years *immediately following. These mills were responsible for* all the early efforts to introduce bamboo. It was by their co-operation with the Indian Forest Department that the possibilities of producing satisfactory pulp and paper from bamboo had been tested and finally demonstrated. It was the success which attended their work which attracted the attention of the outside world and was thus the immediate cause of the establishment of a new Indian mill for the manufacture of bamboo pulp and paper. If *the older mills were thus forestalled it was not from lack of enter*prise on their part as some of their shareholders knew to their sorrow. If bamboo is now established as the staple of a great and growing Indian industry it is to these old mills that no inconsiderable part of the credit belongs. Did the Tariff Board take these facts into consideration in forming their opinion? Was the Board's interpretation of the conditions of "discriminating protection" the correct one? That is a question a new Tariff Board

might well be asked to ponder, for the expansion of India's needs is a factor which might well outweigh nice discriminations in regard to supplies of material.

Paper Industry Satisfies Conditions of Fiscal Policy.—Without entering into a question which might be much debated, it is sufficient to say that in addition to their most valuable work on bamboo the older Indian mills have behind them a long record of valuable service to India throughout many years when survival seemed almost hopeless in face of the fierce competition of the mighty and gigantic wood pulp industry—possessed as that was, and is—of cheaper and more readily convertible supplies of raw material. The 1925 Tariff Board foresaw that "the whole position might be changed if more paper were made from bamboo and if the grass mills could overcome the defects which interfere with the sale of their paper. "In subsequent enquiries it has been made clear that the whole position has been changed and that there is now no need whatever to distinguish between different sections of the paper industry in India. The 1931 Board bluntly declared that "the Paper Industry satisfies the conditions laid down by the Fiscal Commission," while in 1938 the Board suggested the dropping of the discriminatory word "Bamboo" from the title of the Act. They suggested that its object should be declared to be the "fostering and development of the use of indigenous material such as bamboo and grass in the manufacture of paper in India." If any definition is now required it might be better expressed as "the preservation and development of paper making in India as an industry necessary for the country's economic and cultural welfare."

Aim of Fiscal Policy.—Before leaving this subject it is not out of place to call to mind the whole aim and object of India's present fiscal policy. It is "the introduction of a diversity of occupations" without which "no remedy for present evils can be complete." These are not the words of the Fiscal Commission but of the Indian Famine Commission of 1880 whose report was probably the means of initiating the long and wearisome agitation for India's fiscal freedom which eventually led to the abandonment of the narrow tenets of so-called free trade. Incidentally, it may be noted that this report specifically mentioned the paper industry and suggested its fostering and encouragement.

Why Does Paper Need Protection?—A common reproach to the Indian Paper Industry is that it has had plenty of time to establish itself successfully and yet, to-day, under protection, it cannot meet the country's requirements with the result that imports still pour in to the tune of some 150,000 tons, more or less, every year. Here we have to deal with more than one serious misapprehension.

To begin with, paper as such cannot strictly be held to be a protected commodity. Other commodities such as sugar or steel are more accurately thus described since the protective tariff in their cases practically reserves the entire Indian market to Indian producers by applying the protective duty to imports of *all* descriptions. In the case of paper the position is far otherwise because nine-tenths of the imports are free of the protective duty, which applies only to writing paper and to certain carefully distinguished classes of printing paper. Last year the total imports of paper and board were 153,633 tons of which only 13,471 tons, or about $8\frac{3}{4}$ per cent., had to pay the protective duty. Certain imports come in entirely free of duty, while the revenue rate of duty is applicable to ninety per cent. of the total imports. One-third of these imports consist of the waste of the publishing industry, which naturally sell at a price with which no mill in the world can compete. This waste consists of over-issued newspapers and it comes in to supply the needs of innumerable small shopkeepers for a cheap wrapping paper. Of the other imports over 40,000 tons was printing paper (including newsprint) containing mechanical wood pulp, a remarkably cheap material which is not available in India. Strangely enough, this pulp is taxed at the same rate as pulp three times as expensive, hence the Indian mills cannot afford to import it. Other paper imports include the small tonnage of protected qualities already mentioned, about 20,000 tons of packing paper made from wood pulp and 27,000 tons of boards made from straw and other cheap materials.

Mention has already been made of the dominating power of the wood pulp industry in the world's paper markets. In the year 1937 it supplied no less than twenty-six million short tons. It was the enormous and rapid growth of this industry which prevented the full development of India's industry at the end of

last century and later brought it to the verge of ruin. When the sphere of the Indian mills was thus invaded these were by no means antiquated or ill-equipped, and they were, as now, staffed by experienced and highly efficient paper-makers. But the superior advantages inherent in the cheapness of wood pulp completely dominated the position and may, for some time, continue to do so. That time is passing. The two-hundred-year-old trees have been cut down and the world's paper industry, looking round for another raw material, expects that bamboo will eventually supply its needs.

Reasons for Duty on Pulp.—A minor misconception of which something was heard in the debates in the Legislature last April is the idea that the duty on the wood pulp is intended to protect the pulp industry or to help the paper industry. The truth is that in India there is no pulp industry in the sense that pulp of any kind is manufactured for sale. Moreover no Tariff Board has ever expressed the view that a duty on pulp would lead to the establishment of a separate pulp industry, though naturally it might develop when wood pulp becomes much dearer in future. To some extent the pulp duty does protect the existing paper mills as it makes it unprofitable for new mills to come into the market as mere "converting" units unhindered by the trouble and expense of making their own pulp. But its main object was merely to ensure that the development of bamboo pulp would be stimulated by the removal of any temptation to make use of imported pulp.

As already indicated, the duty has hitherto been purely a specific one. To all intents and purposes it remains so. In consequence, we have the anomalous spectacle of imports of paper made of this pulp, while Indian mills are entirely debarred from its use because of a duty which is out of all reasonable proportion to the value of the material. No reason has ever been adduced nor any explanation given for this strange state of affairs. Mechanical pulp is of a character and appearance so widely different from the chemical pulp used in the better classes of paper that the Customs authorities would have no difficulty in distinguishing one kind from the other. But if it is ever desired to encourage the manufacture of the cheaper classes of paper in India it will be necessary

either to admit this pulp free of duty or to discover sources which can be used for its manufacture. Naturally the latter would be the more desirable solution.

Over-production.—By the time the next Tariff enquiry is held it appears that the productive capacity of the Indian mills will have doubled and the output, according to the last Tariff Report, is expected to amount to at least 80,000 tons, an increase on the 1936-37 figures of no less than 31,500 tons. This increase represents two-and-a-quarter times the quantity of the paper of the protected qualities imported last year and even if there should be a greater demand for that class of paper it is clear that there is no hope of avoiding a position of serious over-production unless a very substantial part of the new tonnage can be sold in competition with unprotected classes of paper. Accordingly, the Tariff Board recommended the institution of a further enquiry this year to ascertain "the prospects of Indian mills being able to manufacture classes of paper not at present protected at a price which will enable them to compete with imported paper with the assistance of a moderate protective duty." These words foreshadow the possible extension of the scope of protection and although the Government Resolution on the subject holds out no promise of this it makes the significant remark that when the next Tariff Board is constituted "it is probable that the manufacture of the types of paper which do not at present enjoy protection will be sufficiently advanced to provide reliable data for a review of the industry as a whole." In the meantime, the existing scheme does not help in the new situation and, as pointed out in the 1925 report, tends "to confine the development of the paper trade to certain narrow channels and to prevent its spread over the broad fields it might otherwise occupy."—*Indian Print and Paper*, Vol. 5, No. 1, September, 1939.

The following information is taken from the statement relating to the

IMPORTS

ARTICLES	QUANTITY					
	MONTH OF NOVEMBER			8 MONTHS, 1ST APRIL TO 30TH NOVEMBER		
	1937	1938	1939	1937	1938	1939
WOOD AND TIMBER Teakwood— From Siam (cubic tons)	32	24	..	611	710	30
,, French Indo-China (cubic tons) ..	159	134	301	1,641	2,834	3,046
,, Burma (cubic tons)	13,954	12,435	17,099	1,05,899	1,03,114	1,00,693
,, Java (cubic tons)	711	582	513	3,578	2,382	2,460
,, Other countries (cubic tons) ..	..	..	..	519	20	..
Total ..	14,856	13,175	17,913	1,12,248	1,09,060	1,06,229
Other than Teak— Softwoods (cubic tons)	1,259	1,300	182	12,843	10,318	6,648
Matchwoods (cubic tons) ..	687	891	186	6,950	6,360	5,012
Total ..	1,946	2,191	368	19,793	16,678	11,660
Unspecified (value) ..	..	..	..	..	..	..
Firewood (tons) ..	66	75	53	415	558	356
Sandalwood (tons) ..	..	54	..	109	103	101
Sleepers of wood (tons)	180	72	166	637	248	1,206
Plywood (tons) ..	373	1,007	241	3,469	3,915	4,209
Manufactures of Wood and Timber— Furniture and Cabinetware ..	..	..	..	..	..	..
Other manufactures of wood (value) ..	..	..	..	..	..	..
Total ..	619	1,208	460	4,630	4,824	5,872
Total of Wood and Timber (value) ..	..	..	..	..	..	..
Other Products of Wood and Timber— Wood pulp (cwt.) ..	9,168	26,186	1,510	1,34,965	1,94,361	1,04,194

Seaborne Trade and Navigation of British India for November, 1939:

IMPORTS

ARTICLES	VALUE (Rupees)					
	MONTH OF NOVEMBER			8 MONTHS, 1ST APRIL TO 30TH NOVEMBER		
	1937	1938	1939	1937	1938	1939
WOOD AND TIMBER						
Teakwood—						
From Siam ..	4,311	2,456	..	75,979	91,580	3,336
„ French Indo-China ..	18,486	16,247	33,847	1,88,710	3,44,876	3,30,406
„ Burma ..	18,59,613	16,03,986	25,25,667	1,35,13,375	1,37,02,294	1,29,35,214
„ Java ..	94,180	66,730	59,533	4,54,935	2,39,774	2,60,863
„ Other countries	..	..	..	57,439	2,501	..
Total ..	19,76,590	16,84,419	26,19,047	1,42,90,438	1,43,81,025	1,35,29,819
Other than Teak—						
Softwoods ..	87,345	79,336	13,349	9,74,566	7,18,416	4,48,929
Matchwoods ..	47,767	55,105	11,786	4,27,153	4,22,555	3,48,967
Total ..	1,35,112	1,34,441	25,135	14,01,719	11,40,971	7,97,896
Unspecified ..	3,00,739	2,68,988	2,72,166	17,10,978	20,97,047	1,737,443
Firewood ..	996	825	795	6,228	6,804	5,350
Sandalwood ..	..	12,452	..	33,499	27,851	30,063
Sleepers of wood ..	13,557	8,273	21,167	79,746	40,164	1,60,434
Plywood ..	79,348	1,70,543	41,030	7,33,487	8,27,790	7,96,366
Manufactures of Wood and Timber—						
Furniture and Cabinetware ..	2,13,688	1,25,169	85,159	15,57,327	11,23,897	9,06,914
Other manufactures of wood ..	1,77,047	1,28,867	1,39,057	12,30,112	11,15,111	10,06,451
Total ..	7,85,375	7,15,117	5,62,374	53,51,377	52,38,064	46,43,021
Total value of Wood and Timber ..	26,83,389	24,13,808	31,21,397	1,94,86,207	1,96,36,763	1,80,63,822
Other Products of Wood and Timber—						
Wood pulp ..	77,146	2,11,378	17,774	10,38,517	18,44,735	7,36,097

EXPORTS

ARTICLES	QUANTITY					
	MONTH OF NOVEMBER			8 MONTHS, 1ST APRIL TO 30TH NOVEMBER		
	1937	1938	1939	1937	1938	1939
WOOD AND TIMBER						
Teakwood (cubic tons)—						
To United Kingdom	28	..	..	207	37	20
„ Germany ..	..	..	..	..	1	..
„ Iraq ..	10	18	..	111	176	269
„ Ceylon ..	..	..	..	1	1	30
„ Union of South Africa ..	..	..	..	..	..	..
„ Portuguese East Africa ..	..	..	..	..	..	..
„ United States of America ..	..	..	..	..	..	..
„ Other countries	54	416	9	479	1,577	1,077
Total ..	92	434	9	798	1,792	1,396
Teak keys (tons) ..	..	..	..	..	..	..
Hardwoods other than teak (cubic tons) ..	..	..	..	15	..	..
Unspecified (value) ..	..	..	..	..	..	..
Firewood (tons) ..	..	..	2	115	..	2
Total ..	..	..	2	130	..	2
Sandalwood (tons)—						
To United Kingdom	1	..	..	14	11	..
„ Japan ..	21	..	..	54	43	51
„ United States of America ..	51	..	..	433	307	232
„ Other countries	18	11	52	238	105	198
Total ..	91	11	52	739	466	481
Manufactures of Wood and Timber other than Furniture and Cabinetware (value)	..	..	..	..	..	..
Total volume of Wood and Timber ..	..	..	..	..	..	..
Other Products of Wood and Timber	..	..	..	..	..	..

EXPORTS

ARTICLES	VALUE (RUPEES)					
	MONTH OF NOVEMBER			8 MONTHS, 1ST APRIL TO 31ST NOVEMBER		
	1937	1938	1939	1937	1938	1939
WOOD AND TIMBER						
Teakwood—						
To United Kingdom	3,391	..	..	28,166	4,719	2,600
„ Germany ..	..	..	..	..	150	..
„ Iraq ..	3,583	6,993	..	26,312	53,913	55,134
„ Ceylon ..	..	..	..	146	198	2,145
„ Union of South Africa ..	..	..	..	..	..	..
„ Portuguese East Africa ..	..	..	..	..	..	..
„ United States of America ..	..	..	..	..	..	..
„ Other countries	16,784	1,68,310	3,453	1,35,293	5,81,194	2,36,269
Total ..	23,758	1,75,303	3,453	1,89,917	6,40,174	2,96,148
Teak keys ..	..	..	..	..	..	..
Hardwoods other than teak ..	..	..	..	4,020	72	..
Unspecified ..	25,929	30,535	15,432	9,16,910	1,80,933	1,65,893
Firewood ..	..	..	16	1,027	..	16
Total ..	25,929	30,535	15,448	9,21,957	1,81005	1,65,909
Sandalwood—						
To United Kingdom	1,200	..	..	14,680	12,380	..
„ Japan ..	18,100	..	..	51,610	45,153	54,025
„ United States of America ..	50,000	..	..	4,31,440	3,14,480	2,45,810
„ Other countries	16,040	9,337	51,041	2,36,527	1,04.633	1,85,834
Total ..	85,340	9,337	51,041	7,34,257	4,76,646	4,85,669
Manufactures of Wood and Timber other than Furniture and Cabinetware	19,932	11,016	46,155	1,89,899	2,79,074	2,60,106
Total value of Wood and Timber ..	1,54,959	2,26,191	1,16,097	20,36,030	15,76,899	12,07,832
Other Products of Wood and Timber ..	..	..	..	..	..	..

THE ROLE OF CHEMISTRY IN FORESTRY

PART I

By Dr. S. Krishna

Presidential Address at the Twenty-Seventh Indian Science Congress

In selecting the subject for to-day's address, I have, perhaps, departed from the usual practice of reviewing the progress of chemistry. I have done so with a purpose, namely, to attract your attention to the vast forest wealth of India which has, hitherto, been only partially utilised for the industrial development of the country. The economic possibilities of this source are great and I have attempted, in this address, to point out the part a chemist plays in developing and exploiting them.

Chemistry plays an important part in the domain of forestry, which aims at production, conservation and proper utilisation of the forest wealth. This rich heritage has to be carefully nurtured and properly conserved not only because it is a potential source of income but also because it exerts a moderating influence on the climate and helps in conservation of soil. Thus arises the necessity of scientific silviculture. Since silviculture must necessarily deal with soil as the medium of its culture, soil is, therefore, one of the prime factors which a silviculturist has to consider when dealing with the question of creating new forests or maintenance of the existing ones. He is faced with problems such as—an observed difference in success of regeneration of the same species in two adjoining areas; markedly better development of seedlings on burnt patches; dying off of seedlings in certain areas; etc. Consequently, his collaboration with a soil chemist is of the utmost value to him in correctly understanding some of his problems and arriving at a satisfactory solution of the same. It must be remembered that both soil problems and their solutions are local and vary with economic and ecological conditions, and that methods that are applicable to agriculture in improving the soil are almost invariably ruled out on grounds of economy, in the case of forest soils, where such methods

have to be confined to extremely cheap measures. The practices that are mainly followed to achieve this end are: (1) control of species, grazing and fire and, (2) methods of exploitation. All these practices aim at improving the quality of the crop besides improving the soil conditions. The soil and the plant species that flourish on it are closely bound together and one is practically inseparable from the other. This relationship is most evident in the case of virgin vegetation (not interfered with by human beings) which has developed in balance with the climate and soil. In fact, the soil itself is formed under the influence of the vegetation that grows upon it and which, in the long run, may contribute more to its character than the geological material from which it was originally formed. And, therefore, plant cover, when properly interpreted, gives a clue to the soil type, soil texture, soil composition, etc. Soil composition, similarly, affects the plant composition. This, however, is correct only to a certain degree since the question is complicated by the fact that elements generally present in the soil are by no means the only factors which contribute to the proper development of plants. In agriculture, continuous cropping, for example, may change the picture by depleting the soil of some elements. In forestry, the equivalent of continuous cropping is the pure stand of one species. In this case also the soil possibly gets poorer in one or more of the elements essential for the growth of trees. This would be particularly so if the soil does not regain from the plant the element it has lost, through leaf litter and dead or fallen trees. When such a condition prevails the soil becomes comparatively unsuitable for the healthy growth of that very species which originally established itself. The first indications of this are obtained when seedlings fail to establish themselves. It is not, however, always the poverty of such essential elements that is responsible for deterioration of soil: it is sometimes the excess of similar elements, which, instead of improving the soil, act as toxics. This condition is brought about by trees which absorb the elements from deeper soil and deposit them on the surface through fallen leaves.[1]

The response of the plant to a deficiency or excess of an element can be recognised and measured by the symptoms produced. The actual quantities involved are frequently very minute, and routine chemical procedures are not sufficiently delicate to measure amounts

that produce striking effects on plants. Major elements are not the only ones that are important from this standpoint, secondary elements such as Mn, Cu, Zn, Fe, B are, in some cases, perhaps more necessary.[2] They may be present only a few parts per million of soil and yet without them the plant growth suffers. The question of growing pure forests (which appears advantageous from an economic view-point) or mixed forests is therefore, a very important one and, in the light of recent discoveries, this latter procedure is gaining ground. Mixed and uneven-aged forests are undoubtedly the best for the preservation and improvement of soils since they offer a better "balanced diet" than the forest consisting of one species. This perhaps is due to the fact that the need for nutrients and the power of extracting them from the soils is different for different species, and further because the demand on the soil for the same nutrient by all the species is not simultaneous as it would be during the growing season of a single species. Then again the return of minerals to the soil through leaf litter will be of a nature such that one species will be giving back to the soil more of that element the demand for which may be heavier by another species.

The rôle of organic matter in soil, particularly that of humus which acts as a storehouse of nutrients for growing plants, is important. The organic matter, in a forest, consists of dead roots, leaves, fruits and stems of plants; carcasses of insects, worms and animals, live and dead bacteria, fungi, as well as various products of decomposition of dead residues. It is generally recognised that the soils having greater humus content are more productive than soils having less organic matter and, therefore, it is obvious that care should be taken to preserve the proper quantity of organic matter in the soil. Of all the sources of damage to a forest, that from fire is the most dangerous. It leads to the loss of litter cover and porosity, thinning of stands and increased run-off and erosion. Fire accomplishes in minutes the degree of litter removal that would otherwise be achieved only after years under normal conditions. This sudden removal of litter together with its living population sets in motion a chain of events which leads directly to the deterioration of soil. The soil teems with microscopic life—bacteria, fungi, algæ, protozoa, etc., besides being the home of many larger organisms. Each of these has its effects on soil. The microscopic

organisms, especially, are busy bringing about chemical and physical changes of enormous importance to the soil. Among other things, they break down complex organic substances into simpler forms, furnishing nitrogen for plant growth.

To sum up, the important and significant attribute of the soil is its productivity. A productive soil must furnish the required elements in proper balance which is so essential for the normal growth of plants. This depends upon the fertility and the physical condition of the soil. Both these qualities, so important to plants, are, on the other hand, produced through the activities of plants, animals and micro organisms. Thus the soil is primarily the medium for the growth of all these forms of life and is itself largely a product of their vital activities. On a proper understanding of this cycle of interactions and their control for the benefit of forest vegetation depends the success of silvicultural operations.

The contact of a chemist with a systematic botanist has, hitherto, been only in the direction of identification of plants, which is a preliminary essential to chemical investigation of plant constituents. The chemist, in his turn, is, at times, of help to a botanist, because by examining the chemical constituents he can detect similarity or dissimilarity between plants which the botanist fails to detect by comparing their essential characteristics. It is well-known that the basis of botanical identification is morphology, around which are grouped various characteristics of plants by means of which sub-divisions of a family or group into species are usually made. But plant life is as complex as animal or human life and sometimes in botanically identical plants certain features are noticeable, which have been brought about by special conditions of climate, soil or other factors. Such minor differences are, in many cases, given undue importance and are the origin of many new species or varieties. Such species or varieties do not always contain chemical constituents different from those of the parent type plant. On the other hand, the conditions of climate, soil and other factors may bring about some differences which are of real economic significance, and such differences are not always associated with morphological or visible changes in plants and, therefore, escape the notice of botanists.[3] Several examples could be cited where plants of the same species growing in the same locality under identical conditions

of soil, drainage and moisture are chemically distinct although botanically there is no difference between them. To illustrate this point the case of *Artemisia maritima* growing in Kurram Valley (N.W.F.P.) may be quoted. In this area two varieties of this plant grow side by side, one of them yields nearly 2 per cent. of santonine whilst the other is santonine-free. In mature plants, when they are harvested, there is no botanical characteristic noticeable which would help to differentiate the two. Some years ago, when the price of santonine was very high, a company was floated to exploit the Indian *artemisia* but, due to insufficient botanical and chemical knowledge, the company lost heavily in its very first year. How important is the distinction of the two varieties to the trade is self-evident. It was only when a skilled botanist spent a full growing season on the field that he noticed that in certain *artemisia* plants, when young, the stem was reddish, whilst in others it was green. This difference was visible only for a very short period and on maturity the colour in both changed to brown. It is the red-stemmed variety which yields santonine.[4] This information has been of immense value to the collectors who have, from certain areas, almost eradicated the green-stemmed variety which, for commercial purposes, is absolutely useless. Another example is that of the camphor tree. The Japanese and the Chinese have recognised for a long time the existence of useless and valuable camphor trees. Both these varieties grow side by side in certain districts of Formosa and are botanically identical and yet it is only some trees that yield camphor, while others yield linalool.[5] The cause of this variation is still obscure. Another case is that of *Cymbopogon martini* Stapf, the two varieties of which have not been botanically differentiated; one yields the famous palmrosa oil and the other the "ginger grass" oil.[6] Yet another case is that of *Eucalyptus dives*, four varieties of which exist yielding oils with piperitone content ranging from 5 to 50 per cent., but all these are morphologically indistinguishable in the field or in the herbarium.[7] Many more examples could be given to show how chemistry has helped to differentiate plant species which, botanically, appear identical.

The part that chemistry has played in the discovery, separation, identification and synthesis of growth-promoting substances is now well-known. The economic significance of these discoveries

is sure to be very great, especially in forestry where the question of raising plantations and associated nursery work is, at best, expensive and laborious. At the present time, bio-chemistry is passing through a fruitful period in so far that it is helping materially to solve a few of the more complex problems interconnecting plant physiology and chemistry. It has, for instance, been known for a long time that roots can be induced to grow on the middle of the stem of a plant; but the procedure has been troublesome and lengthy and the results somewhat uncertain. Chemistry has made this orthodox procedure antiquated by producing chemicals, both natural and synthetic, by the help of which it is easy to make roots sprout on the stem of almost any plant. The growth-promoting substances are normally produced in plants in very small quantities, hence their isolation from this source has been expensive, but their location, in a more concentrated form, in human urine has made their separation easy. They are known as auxin-α auxin-β, and hetero-auxin. The chemistry of auxins α and β has not been fully worked out but hetero-auxin has been shown to be identical with indole-acetic acid.[8] This discovery has led to the use of many other chemicals of the type as growth-promoting substances, which, even though chemically different, all produce on plants the same physiological action which is different only in degree. Auxins are distributed through all parts of plants besides its producing zones and it has been established that if a plant is freed from it the growth ceases, though this can be resumed on subsequent application of auxin. Auxins bring about a number of different responses in plants, such as growth by cell elongation, formation of roots, activation of cambium, etc., and any one of the active substances, natural or synthetic, can bring about any or all these responses. This, it may be mentioned, is different from the action of animal hormones which, in general, perform one function only. Study of the use of auxins for rooting of cuttings of commercially important plants (lemons, apples, pears, etc.) is in progress[9] and the possibilities have not yet been fully explored but it is expected that the growth-promoting substances will be of great use in grafting and similar type of propagation work in nursery gardens.

The above is a good example of research where close co-operation between the biologist and the chemist has brought about results

of such practical application and has been instrumental in furthering such remarkable progress in plant physiology. To the horticulturists and nurserymen the synthetic preparations of growth-promoting or growth-regulating substances mean a real gain of immediate practical importance.

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(*To be continued.*)

FIRE PROTECTION IN HIGH HILL FORESTS

By N. G. Pring and Allah Bakhsh

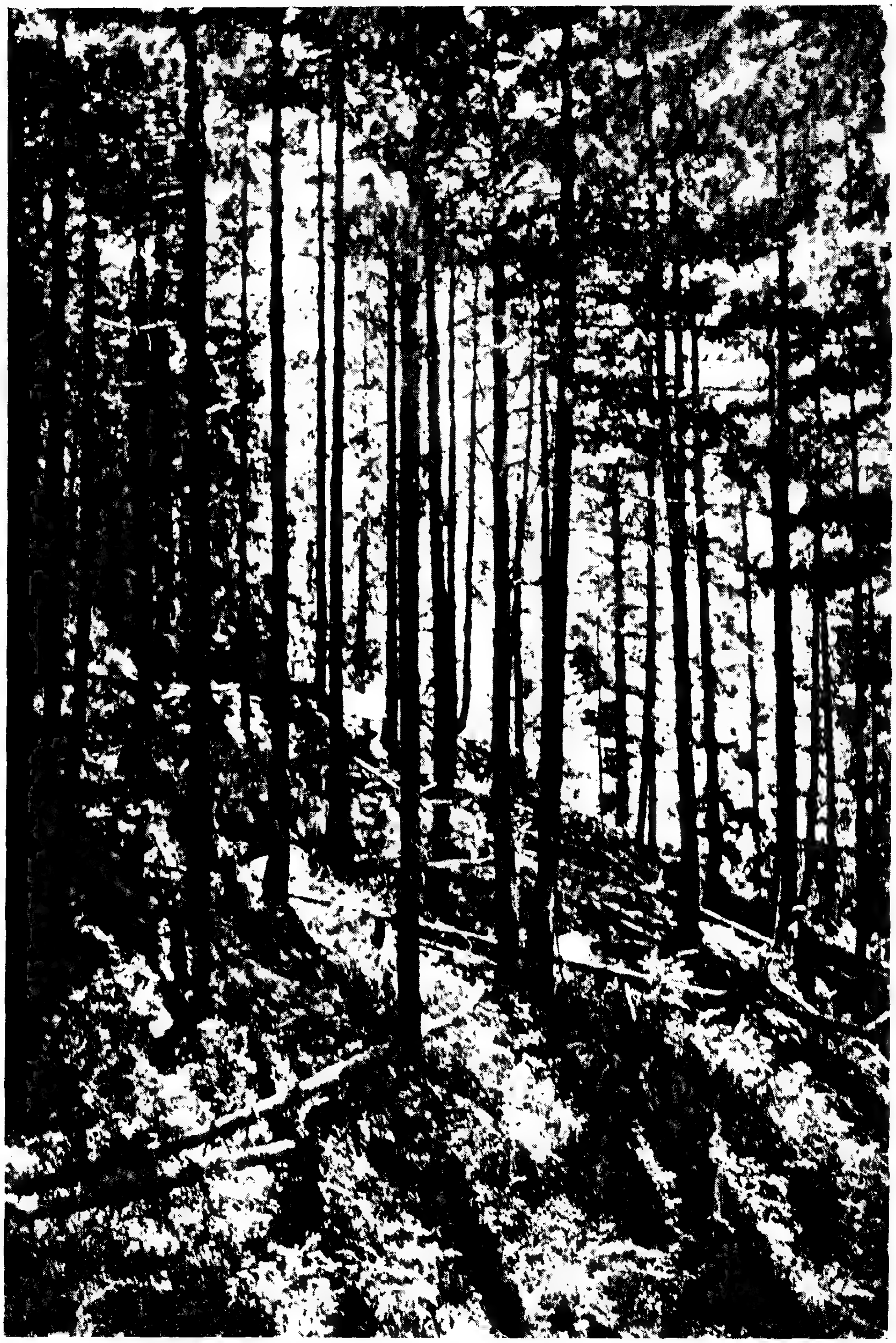
PART II

In the higher hills far from the markets and away from habitations where rightholders' requirements for fuel and timber are negligible, we are faced with a serious problem in the form of unsaleable thinnings. Poles below eight inches in diameter are not convertible into any marketable size and such pole crops have to be

thinned departmentally. If they are left unthinned, not only do they hamper the increment of the future trees, but they also increase fire danger through congestion. Again, in unthinned crops, damage by snow and wind is heavy which results in heavy debris. This, in the event of a fire, leads to serious damage to the remaining crop. Moreover, if stands are not thinned in early age, they will not respond to heavy opening in old age. Unthinned pure stands are severely attacked by *trametes pini* **4** and prevention is best effected by thinnings. But thinning in pole-stands below eight inches in diameter, without dealing with the resulting heavy debris, is extremely dangerous and has, in the past, brought disaster to large areas of established crops. According to present practice, cut stems are left scattered among the standing trees after unsaleable thinnings. An area where such thinnings has been carried out is full of refuse (*see* Plate No. 3) and becomes very inflammable when dry and, in the event of fire, the heat generated is so great that it kills all tree growth. According to Mr. Glover, large areas near Bashla, where unsaleable thinnings were carried out and cut stuff was lying on the ground, were completely destroyed by the 1921 and the 1930 fires. Large areas thus left blank had to be stocked with deodar at great expense. One alternative is to clean heavily at an age when the size of the saplings cut out will be easy to handle and will not create heavy debris on the ground. After cleaning, the spacement of the saplings should correspond approximately to that of *kail* or deodar crops of saleable size (eight inches diameter). The following statement gives the spacement for all quality classes of *kail* and deodar just when they reach saleable size:

Species	*Nearest diameter*	*Spacement*	*No. of stems per acre*
Kail (5)	... 8 inches	11½ feet	377
Deodar (6)	... 8 inches	9½ feet	570

As however, the larger spacement given above at an early date is likely to make the timber knotty and would allow the branches to persist longer, the above spacement can be profitably reduced to eight feet in the case of deodar and 10 feet in the case of *kail* at



Area strewn with stems left after unsaleable thinnings (above foreground).
C. 6(a) Tikkar (Naur Valley).

the final cleaning at sapling stage and this spacement would still avoid the necessity of carrying out unsaleable thinnings.

Kail of two inches diameter and deodar saplings are the most suitable size for final clearing. They are easy to handle single-handed as the removal of cut stems is easy and less expensive. Stems of three inches diameter can be removed single-handed, but are more difficult to handle. They should never be allowed to grow to four inches diameter before final cleaning as they are very difficult to handle single-handed and the cost will go up. The foliage of a two-inch stem is not heavy and, at the time of controlled burning, it will generate less heat than that of three and four-inch stems. If no gaps are available near at hand for dumping cut stems, they may be left scattered among the crop away from living stems without forming heaps. It will be cheaper to plant deodar eight inches apart in the first instance. The cost of planting and weeding per acre will remain low and expense on cleaning work will be altogether avoided.

It may be contended that, in a heavily cleaned crop, blanks will be created in the event of casualties. Both in deodar plantations and *kail* areas natural regeneration of *kail* will occupy such blanks very rapidly and there is nothing really to fear about it. It is possible that wider spacing will produce more branchy timber but the rate of increment in open crops will be considerable and crowns will close up soon. In the case of deodar and *kail*, branches grow 6 and 12 inches respectively (horizontal measurement) in length, at an average, annually. Ordinarily a two-inch diameter stem of *kail* has a maximum spread of crown $4\frac{1}{2}$ inches on either side of stem. The crowns will join up in two to three years and cover up the gap. A slight depreciation in quality, if any, can be easily set against an appreciable gain in quantity. Above all, a much greater certainty against fire is insured, as against a crop where unsaleable thinnings are carried out and stems left lying on the ground.

Fire damage is mainly a question of debris. Damage varies directly with the amount of debris in the area and its proximity to the trees. A large number of forests were examined with a view to determine the extent of fire damage with respect to their distances from hamlets and villages. Damage noticed was tabulated under various heads and the following conclusions were drawn:

(*a*) Heavy damage was found far from habitations, characterised by the presence of heavy thinning and felling refuse and a thick leaf layer. Damage was also heavy in pure *kail* crops, particularly in dense young crops on southern and steep slopes.

(*b*) Much less damage was found near habitations where refuse —fuel-wood and leaf layer —is removed by the villagers and grazing is fairly heavy. Here the demand for timber by right-holders is heavy and crops are well-thinned. Out of many such cases Compartments 47*b* and 47*d* near Sungri are very good examples. The lower portions of these Compartments which are near villages were least effected by the 1921 and 1930 fires while the upper parts which are inaccessible were badly damaged. Damage was also less in open as well as older crops, near *nalas*, on flatter ground and in cooler aspects. A mixture of broad-leaved species also tended towards lesser damage Naur Valley in lower Bashahr, which is a very densely populated area, presents excellent examples of both (*a*) and (*b*) on an extensive scale. Good thinning greatly reduces the effect of ground fires and prevents crown fires. By favouring deodar oak and other broad leaved species, much can be done to reduce the inflammability of a compartment. In mixed crops the reduction of pine near roads and paths affords a considerable measure of protection. In the Punjab 85.3 per cent. of the forest areas are under fire protection. A statement of the areas burnt, number of fires and expenditure on fire protection prepared from the Annual Reports of the Punjab Forest Department from 1900 to 1936 follows (Appendix). A close study of the Statement reveals certain important facts.

Although the percentage of the total area burnt annually does not look to be a very formidable figure (column 5, Appendix) for the whole of the Punjab, yet the following figures for Lower Bashahr Division show that in any particular Division the state of affairs may be terribly disheartening, more specially when particularly valuable forests are destroyed.

Name of Range	1921 Fires			1930 Fires		
	Total area of demarcated forests in 1921-22	Area burnt, acres	Percentage	Total area of demarcated forests in 1930-31	Area burnt, acres	Percentage
1	2	3	4	5	6	7
Lower Pabar	20,142	16,970	84	20,249	14,634	72
Upper Pabar	13,804	8,651	63	13,883	3,596	26
Nogli ..	39,159	22,818	58	22,411	3,605	16
Total ..	73,105	48,439	66	56,543	21,835	39

These figures do not include undemarcated forests. In the whole of Bashahr State 69,513 acres, inclusive of undemarcated forests, were burnt in 1921-22 and 39,846 acres, inclusive of undemarcated forests, were burnt during 1930-31.

If columns 6 and 7 are compared, it is clear (column 8) that in most years the number of intentional fires bears a very high percentage to the total number of fires. This is an index of the unsympathetic attitude of the public, their lack of co-operation and appreciation of forests conservancy. It also points to a need for closer study on our part of the psychology of the rural population dependent on the forests; also of under-currents which actuate incendiarism. Expenditure on fire protection (column 11) does not include expenditure on debris burning in regeneration areas as that operation is primarily for preparing the seed-bed, though later on it contributes also to fire protection of the regeneration area. The average annual expenditure (column 11) on fire protection in the province is only about Rs. 5,400. This is very small as it forms only .27 per cent. (or a little over four annas per hundred rupees) of the total average annual expenditure or, in other words, roughly half pie in the rupee. While we spend roughly Rs. 60 out of every 100 rupees of total expenditure in creating and maintaining our forests ("B" Expenditure column 10) we spend a little over four annas out of Rs. 60 of "B" Expenditure in protecting them against fire, our worst enemy. These figures are given to draw pointed attention to the meagre expenditure on fire protection and to point out that additional expenditure, involved in various operations suggested for better protection of forests, is more than justified.

Mr. Wright, in his Paper **(1)** paragraph 11, states that "greatest damage was done in 1920 fires to forests under exploitation." This

points to debris as the main cause. Next he points out that "damage was almost as great in areas which had been under regeneration for years." This shows that younger crops are more liable to damage and it also points to felling debris in the areas. Further he observes that "unthinned areas were more damaged than thinned areas." This points to congestion as a serious danger. He also states that areas closed to grazing were more damaged than open areas. So it is the small wood and grass that are primarily responsible for fire damage. The essence of fire protection, therefore, definitely, is a clean forest base. Being clean-based, the Kalala forests suffered little or no damage on account of the 1921 and 1930 fires. Every effort, therefore, should be made to keep down debris. Removal of dry trees, by free grant or otherwise, should be encouraged where practicable. Grazing keeps down grass and shrubs and this should be encouraged wherever possible. Much could be done, as a preventive measure, if contractors could be made to so fell, dress and saw the timber that less debris accumulates near the base of trees. It is a favourite practice with the sawyers to establish sawing platforms against trees, especially on steep ground. They do this to save themselves the trouble of driving piles for making the platforms. Pole and middle-aged crops need careful attention after thinning operations. If right-holders' demand for refuse is not considerable, the base of trees should be swept clean to a distance of four to six feet; but heavy refuse should always be removed to eight to ten feet distance. It is the practice to burn debris in P. B. I. and, where possible, in selection areas. The importance of this operation cannot be exaggerated. In order to dispose of as much of the refuse as possible at one time by burning, it is necessary to execute heavy seedling fellings, retaining a smaller number of seed bearers. This would considerably curtail secondary and final fellings and keep down debris in the area. Fresh debris resulting from felling operations is not easy to burn. The first operation after felling, therefore, should consist in removing debris away from the trees and it should not be fired until the following year when it will be comparatively dry. This is one way of keeping down expense in getting rid of this type of refuse. When individual logs have to be burnt, clean round the logs to eight feet distance before burning. The best time to do this is October, or November on southern aspects, but even then it takes a great deal of effort to completely burn them . Heat can be reduced and smouldering induced by adding soil. Ash yields a rich supply of potassium carbonate which is a marketable product. It can be extracted without elaborate apparatus by pouring hot water on ashes and syphoning--syphons can be made locally from bamboos—to extract the potassium

carbonate in solution from the wet ashes and evaporating the product over fire. This leaves potassium carbonate powder in a crude form. Its economic aspect is being worked out with the help of the Industrial Economist and is likely to yield valuable results. It holds promise of providing a paying rural industry. Once the villagers find that this can bring them some additional income, they will utilise all the refuse wood that can be found in the forests and we will have a clean forest floor devoid of all refuse.

The disadvantages of departmental firing are the resultant lowering of the soil and crop quality and the risk to broad-leaved species. Yet so long as incendiarism cannot be entirely checked, is it not a lesser evil to do controlled burning of forests to bring them in a condition to stand a summer fire without harm? That departmental burning is a practical possibility is clear from work done in Lower Bashahr and Chakrata divisions. If controlled burning is not done the leaf layer and grasses will gradually accumulate and a summer fire will give a very severe burn and do lasting damage. Controlled burning once every three to five years will prevent this damage. The exact interval can be determined by experience. It must depend on the time necessary for the accumulation of a sufficient thickness of leaf layer, depending on the density and age of the crop. Where departmental burning is impracticable, removal of the fallen needles (*suhr*) might be undertaken instead. The cost is not likely to exceed the cost of the carefully controlled burning and, in remote areas, the operation might be confined to belts along the borders of the forests, roads and paths, while blanks could be used for heaping and burning unwanted produce. Before the area is burnt, it is very essential that the leaf layer should be swept clean to a distance of about five feet away from the trees and heavy slash removed to eight feet away from the boles. Trees that have been previously damaged by fire must receive careful attention and the ground near their base should be scrupulously cleared as they catch fire more easily. As an additional precaution, all previously damaged *kail* and deodar trees should be treated as follows:

Clean the surface of the burnt part of dry bark, etc., coat it with coal-tar and, when dry, plaster it with 1 inch deep layer of clay soil. This should be repeated whenever the clay plaster falls off. It is unnecessary to burn any debris before running a fire. Any personal effort to ignite chips, etc., should be carefully avoided. The idea is to keep down heat and dispose of refuse gradually by repeated ground fires, at intervals of two to three years. Where very heavy debris is lying in the area, fire should be run only after a shower of rain, as humid air

lowers the speed of burning and hence its intensity. The first fire will consume a large part of the smaller chips and small wood which are really more dangerous, as not only do they burn briskly and create much heat, but also they help to ignite thick refuse logs. For this reason also it is not economical to finish off all refuse in one operation. Two to three successive fires of this nature, repeated at intervals, will, in course of time, consume most of the heavy debris, leaving charred logs which will also disappear by repeated firing, as they rot. If there is no regeneration on the ground the area can be fired without damage after clearing near the base of seed-bearers. Younger crops of *kail* and deodar have a papery bark and will not permit a ground fire through them without damage. In such cases, after the felling is complete, clean the young regeneration to the required spacing, remove debris away from the stems, not permitting the formation of big heaps, and leave the area unburnt until the young crop is fit for controlled burning. There is no alternative but to protect the regeneration area until such time. When the young crop has attained four inches diameter at breast-height, it is ready for controlled burning. If green herbs abound in the area, fire does not progress well in winter. Departmental burning can only be done in normal years during Spring (March and April) and again during Autumn (October and November). It is difficult to run a fire during December in high hills except in very dry years.

In the high hills nature affords us magnificent fire lines in the form of *nalas*, cliffs or precipitous spurs. Artificial fire lines, which are expensive to maintain, are mainly of use on easy ground. At least one fire line proved extremely useful and enabled the fire-fighting staff to save the Nagni block of Kulu in 1931-32 against a gale of wind blowing from an unthinned private forest burning like a furnace. A 60-foot fire line was only just enough to enable a large and efficient force of fire-fighters to stop the fire from crossing. The point to bring out is that quality is better than quantity. If you have a fire line let it be perfectly aligned, sufficiently broad and

properly kept up. The following conclusions reached at the Conference of Forest Conservancy held in Naini Tal in September, 1908, are of interest:

(*a*) The width of a fire line beyond a certain minimum is of lesser importance than the condition of growth in the fire line.

(*b*) Ridge fire lines cleared on both slopes are preferred over any other system of fire lines.

(*c*) Time of burning fire lines is of importance. While it is necessary to prevent growth of grass during the fire season, this is limited by the seasonal conditions suitable for running a fire. Burning must be done at a time when a line burns clean.

Roads and paths are of the greatest value as they facilitate speedy concentration and subsequent operations. Counter-firing is quicker, more effective and definitely safer when undertaken from a road or path. Well swept bridle roads certainly act as checks and many a road has automatically saved the forest on the other side. In recent years contour paths have been aligned through important blocks including P. B. I's. They are likely to prove of the greatest value, particularly in conjunction with breaks or belts of non-inflammable species. Most of the accidental fires are caused by wayfarers. Forest and village paths, frequently used by the public must therefore be fire-traced wherever controlled burning is not done. A list of paths that need fire tracing should be drawn up in each division and dealt with annually along with fire lines. At present the practice is to separate big blocks of forest by only a few fire lines or to have fire lines only round important plantations. In compact blocks of forests the lay-out of fire lines should divide valuable forests into rectangles of roughly 50 to 100 acres, irrespective of the boundary lines of individual forests, utilising the ridges and contour paths for fire lines. This would enable a fire-fighting gang to take up position in a short time for counter-firing at shorter distances and thus save larger areas. In an uphill fire, horizontal fire lines are less useful and their number could be kept down by having a larger number of fire lines at right angle to the contour. In practice an outer fire line need not run strictly along the outer boundary of a forest. It can follow a ridge or a *nala* or other more practicable stretch of country. The best time to make new fire lines is when felling is in progress in a block of forests. Fire lines

may vary from 60 to 150 feet in width according to the locality and the nature of the timber stands. Our present average width is 30 feet. The minimum width of a fire line should not be less than 60 feet. This will also form a reasonable width where areas can be given for cultivation. Fire lines of this width might also be maintained as grass reserves with great advantage. A 60-foot width of fire line dividing the forest block into plots of 50 acres will occupy roughly 8 per cent. of the forest area. If the fire lines divide the forest into plots of 100 acres the fire lines will occupy a little over 5 per cent. of the total area. Surely this is not a big sacrifice for better conservancy.

Mr. Parker suggested planting up of fire lines with deodar. As an experiment, selected fire lines have been planted up 2 × 2 feet (cost Rs. 38 per acre) and 4 × 4 feet (cost Rs. 11 per acre) with deodar in Lower Bashahr division. Close planting, however, works out very expensive and broadcast sowing seems to be a better alternative. The cost of burning fire lines works out to an average of rupee one per acre annually. Wherever in the high hills the fire lines can be stocked with deodar, sown broadcast, or with other suitable species of similar type, this recurring cost could be saved.

For a systematic study of the problem of fire damage we need a change in the method of record of fires. It is very essential that in all important cases of fire the examination of areas accidentally burnt should be so made that useful observations can be recorded for application to prevent fire damage in the future. The record would prove very beneficial as, in course of time, much useful and definite information could be collected for future guidance. Successful fire protection depends more upon the judicious adaptation of protective measures to local conditions such as configuration of the ground, nature of undergrowth, amount of grass, degree of dryness, etc., than upon any abstract theories and, therefore, it is not wise to generalise dogmatically on a matter of such complexity nor to insist on the same methods being employed in all localities. Fire protection measures in high hill forests necessarily narrow down in methods owing to special terrain met with in the hills and it is understood that the measures proposed in this note should be judiciously applied according to local conditions.

APPENDIX

Statement—(*a*) Areas Burnt ;

(*b*) Number of Fires ; and

(*c*) Expenditure on Fire Protection in the Punjab from 1900 to 1936.

Area Statement					Number of Fires			Expenditure				
						Intentional Fires		*Total Expenditure*				
Year.	Area under protection (acres)	Square miles	Area burnt (acres)	Percentage of area burnt	Total number of fires	Number of fires	Percentage of total number of fires	"B" and "C" expenditure	"B" expenditure including capital	Expenditure on fire-protection	Cost per square mile	Expenditure on fire as percentage of total expenditure
1	2	3	4	5	6	7	8	9	10	11	12	13
											Rs. a. p.	
1900-01 ..	581,411	908	3,488	0·6	140	55	39·28	820,753	4,75,920	5,443	5 15 11	·662
1901-02 ..	553,846	865	5,156	0·9	270	75	27·77	927,760	6,01,935	5,377	6 3 6	·579
1902-03 ..	564,595	882	12,410	2	203	80	39·40	11,40,987	7,91,149	4,802	5 7 1	·420
1903-04 ..	551,645	862	4,798	0·9	227	87	38·32	9,55,918	6,13,084	5,909	6 13 8	·006
1904-05 ..	553,373	865	7,652	1·4	143	39	27·20	9,74,009	6,37,912	4,850	5 9 9	·497
1905-06 ..	555,340	868	20,632	3·72	182	43	23·62	12,69,307	9,28,723	4,821	5 8 10	·379
1906-07 ..	587,945	919	2,829	0·48	99	18	18·18	11,57,429	7,94,400	5,046	5 7 10	·435
1907-08 ..	607,828	950	17,153	2·82	380	50	13·15	11,81,668	7,77,253	6,360	6 11 1	·536
1908-09 ..	611,479	955	4,786	0·78	197	25	12·69	8,39,576	4,54,515	7,325	7 10 9	·872
1909-10 ..	672,957	1,051	17,080	2·54	193	36	18·65	6,78,333	2,74,428	6,702	6 6 0	·988
1910-11 ..	666,867	1,042	18,539	2·78	236	61	25·84	7.48,813	3,31,008	6,059	5 13 0	·809
1911-12 ..	667,657	1,043	17,201	2·58	288	121	42·01	7,79,865	3,20,312	6,227	5 15 6	·798
1912-13 ..	660,770	1,032	7,273	1·10	154	42	27·27	8,09,072	3,35,855	6,217	6 0 5	·768
1913 14 ..	678,267	1,060	6,170	0·91	161	30	18·63	9,25,748	4,44,750	4,586	4 5 3	·195
1914-15 ..	672,922	1,051	33,133	4·92	302	160	52·98	9,02,454	4,27,415	4,449	4 3 9	·492
1915 16 ..	687,103	1,074	16,862	2·45	319	49	15·36	9,23,144	4,39,836	4,123	3 13 5	·446
1916-17 ..	684,997	1,070	3,236	0·47	160	19	11·87	9,66,485	5,18,892	3,592	3 5 9	·371
1917-18 ..	677,722	1,059	7,518	1·11	159	45	28·30	12,42,077	7,52,200	3,234	3 0 10	·260
1918-19 ..	770,932	1,205	24,450	3·17	250	71	28·40	18,92,178	13,21,670	3,703	3 1 2	·195
1919-20 ..	774,864	1,211	6,337	0·82	202	58	28·71	25,52,043	18,66,599	3,893	3 3 5	·152
1920-21 ..	746,400	1,166	8,496	1·14	207	26	12·55	35,69,704	23,86,990	3,018	2 9 5	·084
1921-22 ..	792,937	1,239	129,550	16·34	529	251	47·44	43,76,095	32,96,260	9,359	7 8 10	·213
1922-23 ..	780,321	1,219	4,034	0·52	94	24	25·53	48,56,660	36,96,230	7,178	5 14 3	·147
1923-24 ..	779,041	1,217	3,291	0·42	119	28	23·53	29,19,039	18,60,768	5,723	4 11 3	·196
1924-25 ..	778,876	1,217	15,175	1·95	226	78	34·51	26,14,344	15,18,721	5,249	4 5 0	·200
1925-26 ..	832,786	1,301	4,192	0·50	180	41	22·77	27,23,442	16,14,388	4,214	3 3 10	·154
1926-27 ..	851,237	1,330	14,483	1·70	322	103	31·98	31,20,776	19,49,703	4,460	3 5 8	·142
1927-28 ..	844,880	1,320	5,639	0·67	201	66	32·83	29,54,962	17,64,865	4893	3 11 4	·165
1928-29 ..	846,510	1,323	4,420	0·57	196	53	27·04	29,62,181	16,63,026	5,545	4 3 1	·180
1929-30 ..	768,741	1,201	7,421	0·96	233	62	26·61	29,69,186	16,59,887	5,279	4 6 4	·177
1930-31 ..	771,970	1.206	48,615	6·30	207	50	24·15	28,01,849	14,02,962	5,358	4 7 1	·191
1931-32 ..	762,946	1,192	9,724	1·27	273	72	26·37	24,97,928	12,18,924	3,556	2 15 9	·142
1932-33 ..	600,079	938	18,881	3·14	284	117	41·19	22,09,793	9,97,585	4,327	4 9 10	·195
1933-34 ..	587,914	919	4,732	0·80	99	8	8·08	21.37,940	9,43,687	5,256	5 11 6	·245
1934-35 ..	590,356	922	4.322	0·73	193	42	21·76	21,85,458	9,48,883	5,430	5 14 3	·248
1935-36 ..	588,773	920	13,189	2·24	240	71	29·58	21,91,156	9,42,536	5,619	6 1 9	·256
1936-37 ..	588,648	920	4,311	0·73	130	20	15·38	25,77,559	13,14,797	6,407	6 15 5	·249
Average per annum ..		..	..	..	..	..	..	19,28,612	11,73,005	5,377	5 0 2	·27

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THE USE OF TREATED WOODEN POLES IN INDIA FOR ELECTRIC DISTRIBUTION AND SERVICE

By D. Stewart

A most interesting booklet of 34 pages has recently been issued by the International Advisory Office on Wood Preservation, Oranjestroat 9, The Hague, Holland, entitled "Practical Results in the Preservation of Wooden Telegraph and Transmission Poles," by Dr. Edgar Morath.

The publication begins by giving a summary of the results of a survey compiled for the United States of America by collaboration between scientific institutions and the American Wood Preservers' Association. It then gives data for seventeen countries in Europe based on the replies to a questionnaire issued by the International Advisory Office on Wood Preservation and the author to European post office, telegraph and telephone authorities and large power

stations. The replies from seventeen European countries are summarised for each country separately and the result is one of the most interesting and useful abstracts of its kind ever produced.

The following very interesting and striking facts emerge from the summary given by Dr. Morath:

(1) In 1937 in the United States of America, 4,217,621 poles were impregnated of which 98.3 per cent. were impregnated with Coal-Tar Creosote.

(2) The average life of a Creosoted pole in the United States of America, calculated from large-scale investigations undertaken jointly by a number of great telegraph and railway companies, comes to 52.5 years.

(3) The British Post Office has about 3,00,000 poles in service mostly of Scots Pine, treated exclusively with Coal-Tar Creosote. The British authorities estimate the life of Creosoted poles to be 40 years. A photograph of a section of a British Creosoted telegraph pole is reproduced showing that it is perfectly sound after 57 years' service.

(4) In Germany the total number of state telegraph and telephone poles is estimated at 13,000,000. Of the poles standing in 1932 41.64 per cent. had been treated with Coal-Tar Creosote. Of the poles installed in the year 1932, 74.8 per cent. were treated with Coal-Tar Creosote, while the percentage of poles now being treated annually with Coal-Tar Creosote is estimated to be about 80 per cent. This shows the steady advance in the use of Coal-Tar Creosote in Germany at the expense of other preservatives. The probable mean life of German poles based on statistics for 1900-1932 is estimated at:

Coal-Tar Creosote (Rueping Process)	...	33.4 years.
Kyanising (Corrosive Sublimate)	...	26.8 years.
Basilit Treatment	...	16.2 years.

A photograph of a section from a Creosoted German telegraph pole is reproduced showing that it is perfectly sound after 67 years' service. There is no trace of decay or insect attack.

(5) Statistics given for nine of the long-distance power stations in Germany, which have about 1,024,000 wooden poles, show that, amongst preservative treatments adopted, Kyanising occupies first place with 45.1 per cent. and Creosoting second place with 35.4 per cent. When it comes to a calculation of the average life obtained, however, Creosote takes first place with 22 years and Kyanising second place with 16 years. Creosoting treatment is done by the Rueping Process and the absorption of Creosote used is 4.9 to 5.6 lbs. per cubic foot, a fairly low absorption for poles. The United States of America absorption employed is generally 7.7 lbs. per cubic foot and in some cases 9.9 to 11.8 lbs. per cubic foot. This, the author states, is the reason for the much higher average life obtained with Creosoted poles in the United States of America. Dr. Morath does not give the absorption of Creosote used by the British Post Office for telegraph and telephone poles. It is, however, known that, up to 1913, the Bethell Full-Cell Process, with an absorption of 12 lbs. per cubic foot, was employed. From 1913 onwards the British Post Office has employed the Rueping Empty-Cell Process with a final retention of four lbs. per cubic foot. As the oldest poles treated by the Rueping Process have not been more than 26 years in the line, it is rather early to say definitely what effect this cheaper process will have on the average life of the poles.

Many other interesting details are given by Dr. Morath for the various countries in Europe and finally he summarises the position for the whole Continent. Of the timber used in Europe, 76 per cent. are Pine, 18 per cent. Firs, 2 per cent. Lauch, 2 per cent. Oak and 2 per cent. Chestnut. The percentages of preservatives used are:

Coal-Tar Creosote	67%
Corrosive Sublimate	11.8%
Copper Sulphate	15.9%
Basilit, Tanalith U-Salts	3.1%
Other Preservatives	0.2%
Untreated	2.0%
	100.0%

As regards the average length of life obtained with different preservatives for the whole of Europe, the author states: "The average length of life does not admit of comparison because climatic conditions and types of timber in different countries vary very greatly. The following averages should, therefore, be considered with due regard to these reservations:

AVERAGE LIFE OF POLES

Treatment	*Years*
Coal-Tar Creosote	26
Corrosive Sublimate	18.1
Copper Sulphate	20.9
Basilit, Tanalith U-Salts	16.2
Other Preservatives	12
Untreated	9.5

American telegraph companies estimate the average life of Creosoted poles to be about 50 years. This is undoubtedly due to the fact that in the United States of America a greater absorption is prescribed generally than in Europe. Most American poles have 125 kilograms per cubic inch (7.7 lbs. per cubic foot) injected into them and some American companies specify an absorption of 160—190 kilograms per cubic inch (9.9—11.8 lbs. per cubic foot).

Other points to be borne in mind are that untreated poles are usually either naturally resistant (*e.g.*, Chestnut and Oak) or are not exposed to fungus attacks under certain climatic conditions (as in Scandinavia); also that poles treated with copper sulphate are used chiefly in France and Switzerland where wood destroying agents resistant to Copper Salts are less common, and that a large proportion of Copper Sulphate-treated poles receive additional protection by Creosoting the ground line area which is the most exposed.

Time has been too short to form any conclusive opinion on the value of U-Salts.

In spite of these reservations it is clear from the data quoted that Coal-Tar Creosote is by far the best preservative for poles and hence its use surpasses that for all other preservatives taken together. Authorities in India, who are concerned with the use of treated wooden poles, should be grateful to the International Advisory Office on Wood Preservation and to Dr. Morath for the

excellent summary given for Europe and America and should carefully study the data provided. Climatic conditions and the degree of abundance of wood-destroying insects and fungi have an important bearing on the life of treated timber and on the amount of preservative which it is necessary to inject into the timber to preserve it effectively against these wood-destroying agents. Conditions in Europe are comparatively mild climatically and the most potent wood-destroying agent in the world, the white ant, is absent. In the United States of America, climatic conditions, due to extremes of summer and winter temperatures, are more severe on wood, and the white ant is prevalent in parts of the country. It is not surprising, therefore, that in the United States of America higher absorptions of Coal-Tar Creosote are considered necessary to preserve poles. It is clear also from the statistics quoted above that this higher absorption is abundantly justified, as in the United States of America wooden poles give an average life of about 50 years as compared with about 26 years in Europe.

In India, conditions are more severe than in the United States of America both climatically and in abundance of wood-destroying termites and fungi. Also the practice of wood preservation in India (apart from the treatment of railway sleepers) is still in an undeveloped state. Wooden poles which must have about one-sixth of their entire length permanently buried in the soil require more thorough preservative treatment than railway sleepers which are normally laid on well drained ballast. It can, therefore, be readily appreciated that effective preservation of poles against termites and the leaching-out effects of the Indian monsoon is not an easy or simple process which can be rapidly solved by laboratory experiments or accelerated tests. Well-planned tests with different preservatives and absorptions under actual service conditions and extending over a considerable number of years are essential. However useful laboratory work and accelerated tests with small wood specimens may be in giving some indication of the value of a preservative, lengthy tests under service conditions alone can be relied on to give the final verdict. This has been realised in other parts of the world, and the lesson is now being learnt in India at considerable cost. In the case of electric transmission poles it is particularly necessary to issue a warning that reliance should be placed

only on the results of lengthy tests under service conditions. The collapse of any portion of the line through failure of poles is likely to cause considerable danger to human life. With improperly treated wooden poles decay is very likely to take place in the interior of the poles and to remain undetected until the poles suddenly collapse. Where such obvious danger is involved it is essential to restrain enthusiasm for timber development in the interests of public safety.

So far as I am aware, treated wooden poles for electric transmission have not been in use in India on any scale, for a longer period than 10 years in parts of Southern India and four years in parts of Northern India. In one large state in Southern India about eight thousand poles treated with a mixture of Wood-Tar Creosote, Coal-Tar Creosote, Neutral Oil and Refined Tar in different proportions were erected between 1929 and 1931. Between 1931 and 1936 a 50: 50 mixture of Coal-Tar Creosote and Fuel Oil was used for about 7,500 poles in the same state, and, during 1936 and 1937, about 3,500 poles were treated with a newly patented water-soluble preservative. Data available up to date show that poles in which Wood-Tar Creosote was used have not done well but the poles treated with Coal-Tar Creosote and Fuel Oil are still sound after a period of service varying from three to eight years. The poles treated with the water-soluble preservative have been in service for less than four years but up to 1938 their condition was said to be satisfactory.

In two separate Provinces in Northern India nearly ten thousand *sal* (*Shorea robusta*) poles and a smaller number of *chir* (*Pinus longifolia*) poles were erected between 1935 and early 1939. These poles were treated with the same cold-water-soluble patented preservative referred to above. This preservative was invented in India and patented as recently as 1935. The results of its use in treating the above-mentioned *sal* and *chir* poles have been disastrous and have provided a good example of the necessity for properly controlled tests under service conditions before any new and untried wood preservative is applied on an extensive commercial scale. In less than three years a large number of the *sal* poles had deteriorated to an extent which compelled the authorities concerned to remove them in the interests of public safety and

replace them by steel poles. The deterioration of a large number of the *chir* poles has been even more rapid and it appears likely that they also will have to be supplanted by steel poles. The reasons for these unfortunate failures are not capable of simple analysis. In the case of the *sal* poles there is grave doubt about the original soundness of many of the poles. In the case of the *chir* poles there is little or no doubt on this point. It seems clear that the poles were in good condition prior to treatment. This would appear to limit the reasons for failure to the preservative itself or to the method of treatment. The penetration and absorption of the preservative obtained under the method of treatment adopted has been found by analysis to be extremely poor, in fact so poor that it could not be expected to give the poles any substantial degree of immunity from white-ant and fungus attack. It cannot, therefore, at present, be said that the preservative itself is lacking in toxicity. Toxicity alone, however, is not the only essential quality in a wood preservative. Unless the preservative can be injected into wood in sufficient quantity and to a sufficient depth, easily and reasonably cheaply, it fails to comply with the essential criteria of a good wood preservative. Most Indian timbers are notoriously bad splitters and, in their case, deep penetration is particularly essential, otherwise termites and fungi are provided with a clear avenue of attack to the central, untreated portion of the pole. In the case of poles with naturally durable heartwood, deep penetration is not so essential but the number of Indian timbers with a heartwood durability exceeding eight years when buried in the ground is very small. Easy and good penetration of timber at reasonable cost is, therefore, an essential quality in any preservative.

In India the sapwood of all timbers is particularly liable to very rapid fungus attack which, in its early stages, is difficult to detect. Wood affected by early fungus attack requires a large dose of a cold-water soluble preservative to render the fungus innocuous, but if a hot-oil preservative is used, the heat required for the preservative treatment is in itself sufficient to sterilise the wood and render a light incipient fungus attack innocuous. This, therefore, in the conditions prevailing in India, which are particularly favourable to early fungus attack, is a very strong point in favour of the employment of a preservative which requires to be injected

into the timber hot. It must be pointed out that the water-soluble preservative already referred to cannot be used hot. It must be used as a cold water solution.

The question naturally arises as to why, in the early stages of wooden pole preservative treatment in India, a newly patented water-soluble preservative was largely used instead of Coal-Tar Creosote which is the oldest and best tried wood preservative in the world and has given excellent results in America and in Europe. The answer is largely concerned with cost and simplicity of treatment. Pressure treatment with creosote has hitherto been considered to involve an expensive plant, and the price of Coal-Tar Creosote is higher in India than in Europe or America. Preliminary laboratory and accelerated tests with a new water-soluble preservative seemed to indicate that it could be used cheaply and effectively in a simple, low-pressure cylinder operated by a hand pump. Operations on a large scale do not appear to bear out these initial hopes. In fact it seems that if this preservative is at all capable of successfully preserving poles the absorption, penetration and pressure employed will have to be increased and the plant will probably have to be remodelled to an extent which will give it little or no advantage in cost as compared with Coal-Tar Creosote. In fact it is possible that where large Creosoting plants already exist in India, erected primarily for the treatment of railway sleepers, Creosote treatment of poles, with a heavier absorption than that prescribed in America, can be carried out at a cost not exceeding that of the poles inadequately treated with a water solution which have given a miserably short life. Also there should be no great engineering difficulty involved in the designing and manufacturing in India of small-scale Creosoting pressure plants with heating equipment suitable for the treatment of poles on any scale desired, and it is understood that this matter is now receiving active attention.

To sum up, it is clear that Coal-Tar Creosote occupies an unchallengeable position in Europe and America as the best preservative for the treatment of wooden poles. It has definitely and emphatically relegated all water-soluble preservatives to a position of very minor importance. It has been used for over 100 years and has not been found wanting. There is nothing in Indian

conditions to suggest that Coal-Tar Creosote will fail to give good results with wooden poles provided a somewhat heavier absorption than is employed in America is insisted on, as wood-destroying agents in India are admittedly more potent. It is suggested that poles in India should be treated with a good type of high boiling Creosote and a minimum absorption of 10 lbs. of Creosote plus 5 lbs. of Fuel Oil per cubic foot should be prescribed. If a high boiling Creosote is used it is quite possible that open-tank treatment will give good results with some species of Indian timber which have durable heartwood and the sapwood of which is easily penetrable under open-tank conditions. Open-tank treatment with high boiling Creosote of the Green Oil type has, in some cases, given excellent results with railway sleepers in India.

It has been emphasised that the preservative treatment of wooden poles is still in its infancy in India and, in fact, is still very much in the experimental stage. It is possible, however, that during the present war the price of tubular steel poles and iron rails, which are at present largely used for electric transmission and distribution purposes in India, will increase to such an extent as to compel the use of treated wooden poles on a fairly extensive scale. Should such prove to be the case it seems obvious that the preservative to be used should be the one which has given unquestionably the best results in other parts of the world, namely, Coal-Tar Creosote, with or without admixture with Fuel Oil.

RIVER TRAINING WORKS

By J. L. Harrison

When rainfall and flooding are considered as affecting the Forest Department, the problem which immediately comes to the fore is: how to check the insidious and ever-increasing removal of the fertile soil from the hill slopes, which fertile soil is carried down at least to the plains, if not to the sea, leaving barren hill-sides? This problem of widespread erosion is a matter for special study and for the attention of Governments, Central as well as Provincial, and is now receiving tardy recognition. There has been detailed investigation over some years and much data has

been collected and published and I do not propose to deal with such problems here.

What the average Forest Officer very often has to consider, however, is some problem connected with river training. It may be, that a fast-flowing stream has to be controlled at certain points, or, as is more probable, that some river in an alluvial plain is eroding, especially at flood times. Any fast-flowing stream is to be found in the higher elevations where the harder strata are to be met with and a stream of this nature has, in course of time, carved out a definite deep bed for itself. Any river training consists in strengthening the bank at some point by means of a concrete or masonry wall, well bedded. The particular problem I propose to discuss is: what measures to take to control the course of a river in an alluvial plain?

In any alluvial area, a river never flows in a straight course for more than a very short stretch and not only meanders about its general bed but frequently alters the course of its general bed. The flow of water has a scouring action on the bottom and sides of the river bed. To start each class of material in motion, a certain velocity of the stream must be attained. While the normal flow of any stream will cause scour only at certain points in the bed, where, for some reason, there is a temporary increase in the velocity, yet at flood times, the increased flow causes scour to a varying degree.

Scouring takes place at the bends of a river and the action of the river flow at any bend can be considered. The two drawings, Figs. 1 and 2 in Plate 4, showing the plan and the sectional elevation of a river at a bend, will explain what takes place.

At any bend, the centrifugal force causes an outward pressure which results in the level of the stream being highest *near the outer bank.* With any river flow, however, the velocity of the current is greatest on the surface and increases towards the centre of the current. At the lower-level stream flow, the river bed causes a reduction in the velocity and also in the centrifugal force. The higher level of the stream flow at the outside of the bend results in the water near the bottom at the outside of the bend flowing inwards, carrying with it sand, gravel, etc., which is deposited at the inner bank. When the stream is in flood, the surface velocity

is at its maximum near the outer bank and at its minimum near the inner bank and the increased velocity of the flow on the outer bank causes erosion.

No river in any alluvial area is ever stable and with the greatly varying discharge of the river there is a constant change of channel. The increased velocity at the bends results not only in erosion there but in the deepening of the channel. While at the bends the river is deeper, in most of the straights it is shallower. Any change of velocity from high to low in a stream carrying material in suspension must result in some portion of the material being deposited with a consequent silting up of the channel. The drawings, Figs. 3 and 4 in Plate 4, show what often happens in the straights of an alluvial river. More and more silt tends to be deposited in the straights. Once the channel there becomes too shallow, the increase of flow in flood times will result in the river tending to strike out in a new channel. The old channel is shown with dotted lines. With the strata to be met with in any alluvial district, it is a comparatively easy matter for a river to cut into the banks, as any increase in velocity will remove most material met with.

A formation occasionally met with is a long loop. The drawing, Fig. 5 in Plate 4, gives an idea of the type of formation. The river may extend and extend the loop and then, when the neck of land is fairly narrow, the river decides to cut through the neck and take up a course, as shown by the dotted lines, until it cuts through completely. In any such case there is bound to be heavy erosion elsewhere, as a river flowing through soil of uniform density has a fairly constant length and, where any length is lost in one locality, such length has to be made up elsewhere.

Any river training works for main rivers is a work of magnitude far outside the scope of the Forest Department. Our problems consist either in protecting a bridge from serious erosion or in discouraging erosion in some area on which there are buildings or valuable forests to be protected.

For the most part, although an alluvial river may keep on changing its channel, its bed remains fairly constant, and the river meanders within certain limits. Thus satisfactory results can usually be obtained if steps are taken to *guide* the river rather than *obstruct* it.

RIVER TRAINING WORKS

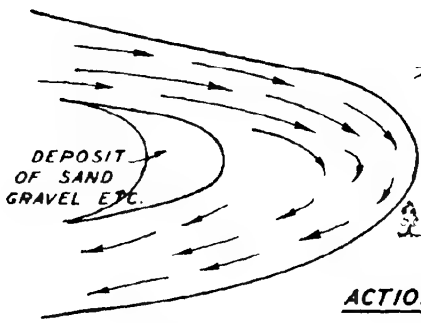


Fig. 1.

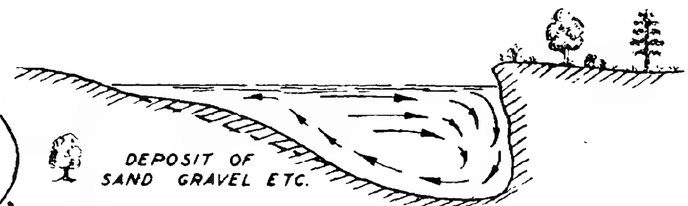


Fig. 2

ACTION OF RIVER FLOW AT BEND IN RIVER

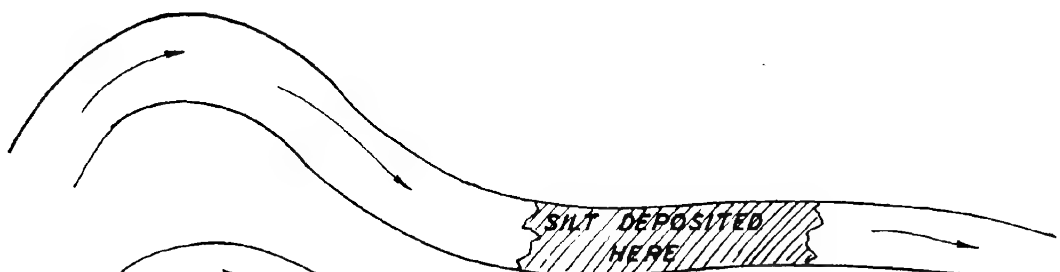


Fig 3

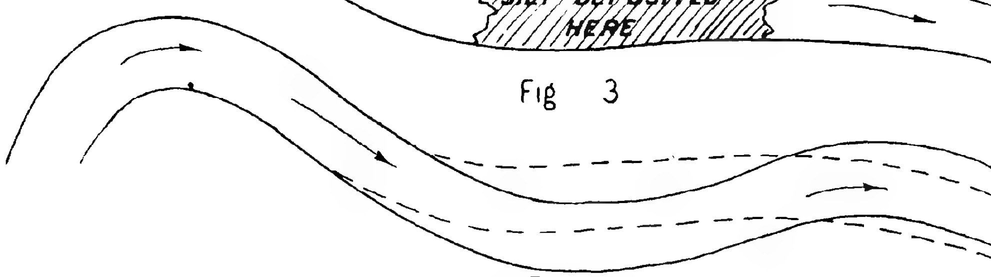
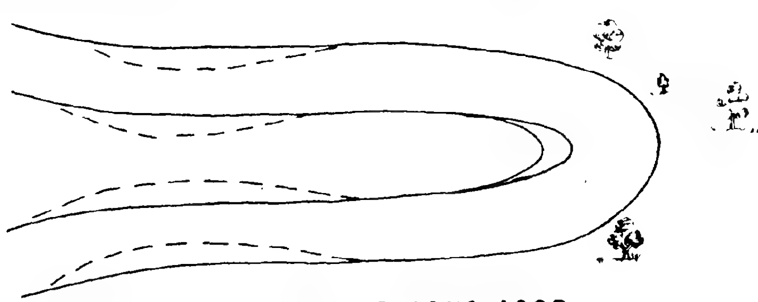


Fig 4.

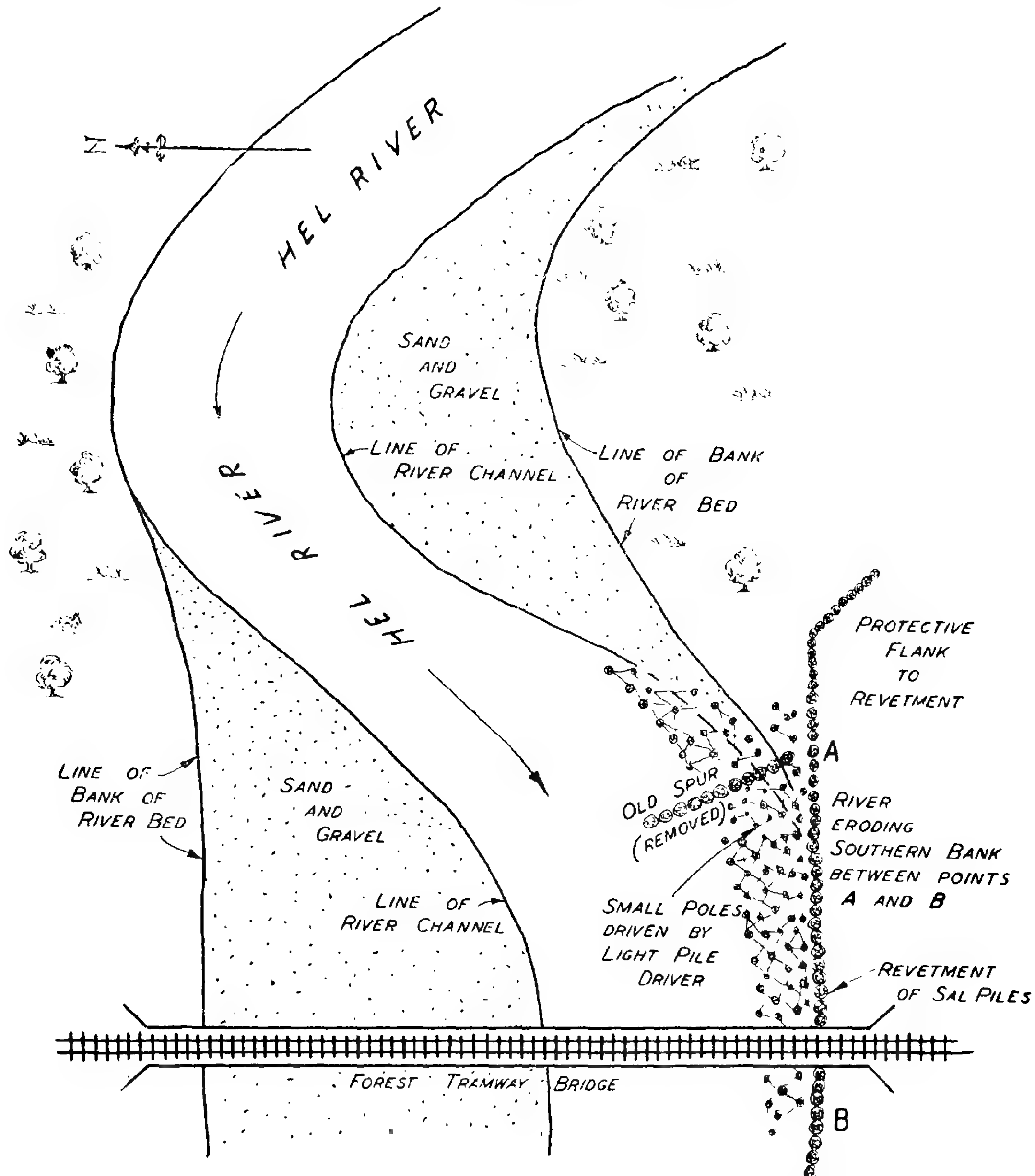
POSSIBLE ACTION OF RIVER AT STRAIGHT



PROBABLE ACTION OF RIVER AT LONG LOOP

Fig 5.

RIVER TRAINING WORKS



PROTECTION WORKS CARRIED OUT ON HEL RIVER, ASSAM, FOR STOPPING EROSION ON SOUTHERN BANK NEAR BRIDGE

Fig. 6.

Protection to the banks can be given by:

A.—Revetting and

B.—Guide Bunds.

While revetment of the banks in conjunction either with guide bunds or some structure which induces silting or at least prevents erosion usually produces satisfactory results, it is seldom that revetment alone produces any lasting success. It has already been noted that the reduction in velocity of the stream flow results in the deposit of silt. What should be aimed at is to discourage the stream from eroding the bank at the danger point and to encourage the stream to deposit silt at such site.

Each class of material requires a certain velocity to start it in motion. The erosive power of water varies as the square of its velocity and its transporting power varies as the sixth power of the velocity. The table as given below shows the effect of velocities on various materials:

Material.	Bottom Velocities in Feet per second at which—		
	Transportation begins	Material is in equilibrium	Deposition begins
Coarse and	1·00	·70	·60
Gravel—size of pea ..	·70	·60	·7
Gravel—size of small bean ..	1·60	1·00	·7
Shingle—rounded and one inch or more in diameter ..	3·2	2·2	1·6
Flints—size of hen's egg ..	4·00	3·20	2·20

It will be noted that with each class of material, while a certain velocity must be attained to set the material in motion, yet, once the material is in motion, the velocity can fall appreciably below this initial velocity before the material is again deposited.

While any revetment of the nature of a brick or stone masonry or concrete wall against a bank would withstand any stream flow so far as the face of the wall and the upper structure were concerned, the danger with such a structure lies in the foundations being undermined by erosion. Any interference with a stream flow tends to cause scour. Unless the nature of the river bank is such that any revetment wall can be built up on a good solid foundation, some other form of revetment is advisable. A more suitable material

for revetment is, in most cases, readily available, namely, wooden piles. In river training works of any importance, these piles should be driven by a pile-driver.

Pile-driving is an operation with which most Forest Officers are conversant and there is no need for me to discuss the question of pile-driving here. What I would emphasise is, however, that any piles used in any protection works should be sufficiently large and of some durable species. If the work is of any importance then it is worth doing well and the piles used should be of some durable species dressed to heartwood rather than poles of some uncertain species, used by reason of the fact that they have no outside market value.

For supporting the bank, good piles from a strength point of view could be spaced at three feet or more apart. Where, however, they have to be driven well down into an existing bank there are difficulties to be met. To have a proper backing to the revetment, the piles would have to be driven side by side, a lengthy and expensive undertaking, or a backing of heavy gauge corrugated iron sheeting can, where only silt has to be penetrated, be driven in behind the piles. In a protection work in Assam, I drove in 18-gauge corrugated iron sheets to a depth of about eight feet behind a row of piles at about two-feet centres. The driving of the corrugated iron sheets was done slowly by means of a light pile-driver, consisting of a wooden monkey working up and down in a frame made from two lengths of 24 lb. rail. To minimise buckling at the driven end of the corrugated iron sheet I had to clamp two pieces of wood along the edge and fit another length of wood between the monkey and the top of the sheet in order to distribute the blow more effectively along the edge. Too wide a space cannot be left between the piles, as the longitudinal section of the sheet has to take the pressure of the bank.

Where a protective wall can be built up and a backing given later, the construction of any revetment is greatly simplified. Piles can be driven, three feet apart or more, and cross battens or rails fixed between the piles, which will take the thrust of the corrugated iron sheets. The photographs in Plates 6 and 7, clearly show the type of construction used.

With any revetment along an endangered bank, it is essential that protection be given to the foundations or foot of the revetment. In some cases definite obstruction is given by means of *spurs* but the alternative is not to obstruct the flow along the particular bank but to slow up the current. Such slowing up can be carried out by driving in small poles, three or more feet apart, in the stream bed near and above the threatened section of the bank. The arrangement of these small poles is shown in the photograph taken upstream from a forest tramway bridge which was threatened. These poles were driven by means of a light pile-driver of the type used for driving in the corrugated iron sheets. In some cases the poles could be driven by means of a heavy maul but such requires a strong man to wield it and such men are seldom available. It is very essential that the poles should be well driven in as they have to withstand a strong current in flood time. A stronger and more satisfactory job is done if the poles are connected by plain galvanised wire. With such a construction there is less chance of any weak pole or poles being uprooted at the flood period when their presence in the stream bed is most necessary.

An important forest tramway bridge in Assam was continually being threatened and one or two bays had to be added owing to the cutting away of the southern bank. The plan, Fig. 6 (Plate 5) will best illustrate the protective works which had to be carried out and the photographs clearly show the excellent results achieved. The river concerned was the Hel River (for some time we considered the name as very apt) and like most rivers in the Goalpara District, it carried down a tremendous volume of water in flood time. Constant erosion was going on at and above the forest tramway bridge at the southern bank and various forms of protective revetment had been considered. A spur had been constructed of piles just above the bridge in an attempt to stop the erosion but by reason of such spur being at right angles to the stream flow, the spur had done rather more harm than good and there was accelerated scouring on the downstream side. Steps had to be taken to protect the southern bank from further erosion and to encourage silting at and above the threatened bridge. For the protection of the bank, piles were driven further apart and corrugated iron sheets driven in behind to support the high bank. At the foot of these piles "sausages"

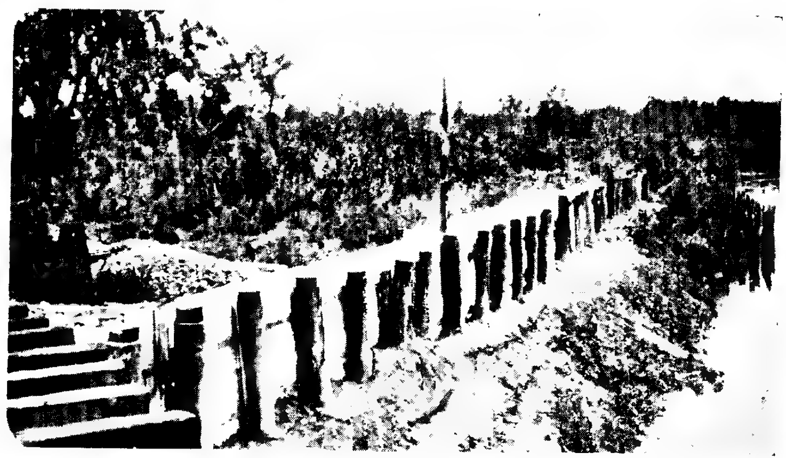
made from small boulders enclosed in wrappings of wire netting were laid. Such sausages minimise the scouring action of the water and as any sand, etc., is scoured out from below they settle down into place. For six to eight feet into the stream bed near the bridge small sal poles were driven by means of a light pile-driver. These were connected by galvanised wire. Farther up from the bridge these small poles were further extended into the stream bed as shewn in the photographs in Plate 6, and the outer edge of these poles was laid in a curve such as it was hoped the flow of the stream would finally follow. The height of the small poles above the stream bed was only three to four feet and a lesser height would have sufficed. It is not desirable that these poles should project too high otherwise floating debris would be apt to get caught and cause scouring. The deposit of silt takes place to the greatest extent during the subsidence of the flood water.

The three photographs in Plate 7, were taken each time from the same place on the southern end of the bridge, facing upstream, and shew the very satisfactory results obtained. The second photograph was taken over a year after the first photograph (taken when the poles were first driven in), and the third photograph about two years later. The middle photograph shews the silting process at its intermediate stage. Had the excellent results with the small poles been visualised there would have been no need to extend the protective revetment of piles so far downstream. The last photograph shews this protective revetment with its flank extending well away from the final bank. However, at the time no chances could be taken and while, with the successful results with the "belt," the "braces" were not required, yet they might have been and nothing could have been done during the all-important flood time with the stream running full, bank to bank. For any further work of this nature reliance would be placed mainly on the fixing of the small poles to induce silting at the danger point.

Where there is undue scouring at the bend of a river, attempts have been made on occasion to reduce any such scouring action by cutting a channel across a bend with the intention of throwing the flow of the stream away from a threatened bank. An alluvial stream brings down a tremendous amount of silt during flood time and anyone who has observed any such stream or river in flood time

RIVER TRAINING WORKS

Revetment with piles backed with old rails and galvanised corrugated iron sheeting.



Another view of the above type of revetment.

Light poles driven by light pile-driver and connected by plain wire; designed to slow up the river flow and cause silting.

RIVER TRAINING WORKS

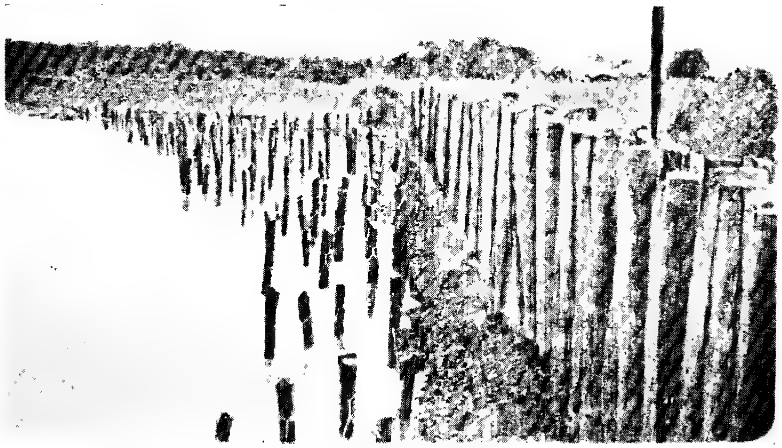


Photo taken from southern end of bridge shewing initial stage of revetment works and light poles driven in the stream bed.

Photo taken from the same spot about a year later.

Photo taken from the same spot about two years after the first photo was taken.

will appreciate the rapidity with which a river can fill up one channel and cut out another. Cutting any such channel reduces the length of the stream. The channel has to be cut by manual labour and costs a great deal. While initially there may be a flow down such a channel, it very soon silts up again and any such scheme, from my own personal observation but *not* experience, is not to be recommended.

We now come to the use of *spurs* or *bunds* built out into the stream. Such works are necessary on the larger rivers and are the subject of special study. Small spurs can usefully be employed by Forest Officers, however, and to obtain satisfactory results some of the general principles on their construction have to be understood. One too often finds instances where spurs or bunds have been erected into the stream at *right angles to the flow*. Such is about the *worst angle* which could be chosen for this sort of protection work. With stream flow of any extent, a bund or spur set out at right angles results in undue scour on the downstream side resulting in heavy erosion of the bank and often destruction of the spur.

In all cases where spurs are employed the question of downstream eddies has to be given particular consideration and every measure taken to minimise such.

While, so far as I know, it has never been proved why such should be so, experience has shown that in the construction of any spur or series of spurs, the *best results are obtained with pointing the spurs upstream and with the downstream face of the spur making an angle of 30° with the direction of the stream flow*. Much, if not all, of the success in any scheme involving the use of spurs depends on the angle at which such are laid.

With several spurs laid round a threatened bend in a river, the angle at which each spur was laid would vary according to the flow. A series of spurs which I fixed in one river and which produced very good results were laid out somewhat as shewn in the accompanying drawing, Fig. 7, Plate 8.

The drawings, Figs. 8 and 9 in Plate 8, shew the plan and cross-sectional elevation of a type of spur which can be used either upstream or downstream and which can readily be fixed in most places. The spurs can be made of stout bamboos or of poles of *sal* or any other suitable species. Jungle-wood poles can be used if need be. The poles, if of timber, can be of three inches diameter upwards, according to supplies available and to the strain they may have to bear. What force they will have to contend with will also decide the distance apart they should be driven. The poles should be driven rather than handshaken into position and for any such driving a

light pile-driver can readily be constructed. The normal distance apart is three feet. The spur starts well up the river bank and slopes down into the stream. The nose of the spur can be only a little above the stream bed. The poles are braced with plain wire and in between the two rows of poles should be filled in with brushwood. The spurs could be made reasonably impermeable by fitting a lining to the inside of the poles and filling up with sand, gravel, etc., but, in my personal opinion, it is better to allow water to percolate through the spurs and such construction is cheaper and more readily maintained.

No hard-and-fast rule can be laid down as regards the *length* which spurs should be extended out into the stream bed. If some length is required as a guide I would give a normal length of twenty-five feet. With a broad, normally slow flowing river the length could be increased but in the case of a narrower, faster flowing river, the length would be reduced to twenty feet or less and the poles driven closer together.

Another point which arises is what the distance should be between each spur. The normal assumption is that a spur protects three times its own length of the downstream bank and, in favourable circumstances, may protect about five times its own length of the bank. Where a series of spurs are fixed, however, what has to be guarded against is that there are no eddies between any two spurs causing undue scour and resulting damage to either spur. In one case where spurs made from *sal* poles were successfully used, I had the spurs only fifty feet apart and less harm would result from having the spurs too close than too far apart. Moreover, as in the case of all river protection works, it has to be remembered that the danger period is during the flood period when no driving of any poles in the stream bed is possible.

For more important works the Public Works Department have made use of spurs of the three types as shewn in the drawings, Figs. 10, 11, and 12 in Plate 8, and the results have, in most cases, been very satisfactory. I have shewn the construction as made with driven piles but such spurs have been made of concrete and stone masonry. The great advantage of piles, where such can be driven, is that any scour does not affect the foundations of any spur and in few cases will suitable timber piles not be available to our Department. From my own personal experience I have had very satisfactory results from the more simple type of spur as described and such is rather simpler to construct than the three alternative forms as shewn.

RIVER TRAINING WORKS

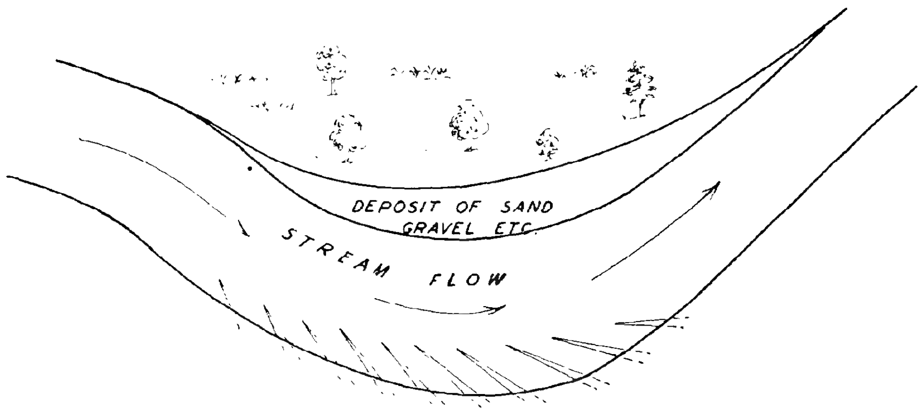
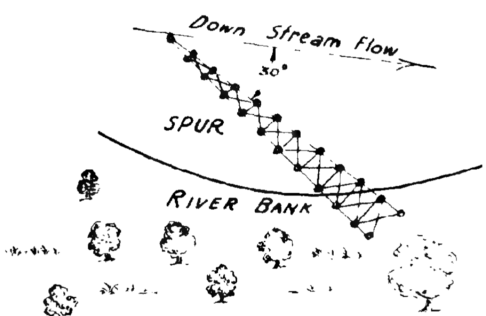


Fig. 7

USE OF SPURS TO COUNTERACT EROSION AT A BEND



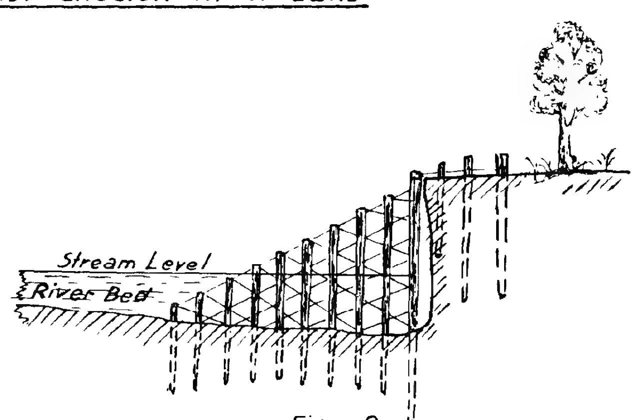


Fig 8 Fig. 9.

PLAN AND CROSS SECTIONAL ELEVATION UPSTREAM SPUR

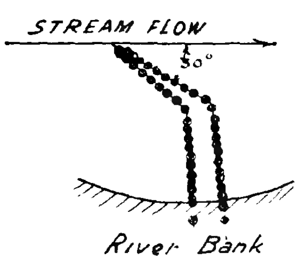


Fig 10

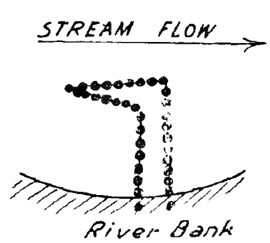


Fig. 11

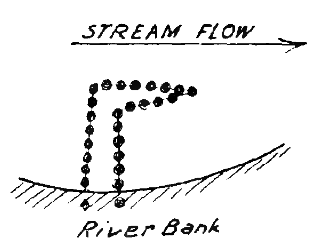


Fig. 12.

ALTERNATIVE FORMS OF SPURS FOUND SATISFACTORY IN SOME CASES

EXTRACTS

DEVELOPMENT OF FORESTS

Considerable attention has nowadays come to be paid to the development of forests in India though a good deal more has to be done than has been achieved. Forests, properly exploited, will prove to be financially as well as otherwise paying propositions. But for this, wise initial and continuous expenditure on them is necessary. The need for this is recognised in most progressive states to day especially so in new countries. In some of them, part of the receipts from forests every year is earmarked for expenditure on them calculated further to develop them to the nation's advantage. Thus in Western Australia the State Department spent, we are told, £60,000 during the year ending June last on afforestation and reforestation. The Forest Act there indeed provides that three-fourths of the net revenue of the Forest Department shall, in every financial year, be credited to a fund for reforestation and improvement of forests. In other countries, it

may not be necessary meticulously to promote such a fund: but statesmanship everywhere demands that satisfactory provision should be made for developmental expenditure on forests—*The Hindu*, dated December 5, 1939.

IMPROVEMENT OF WEST BENGAL FORESTS

COMMITTEE'S REPORT: CONTROL SCHEME AND CESS

A comprehensive scheme for the preservation of forests in West Bengal is contained in the Report of the West Bengal Forest Committee, a summary of which was issued in the form of a Press Note in Calcutta.

The Committee is of the view that control of some kind over the management of private forests is inevitable in order to save these forests from deterioration.

As regards the release of "vested" forests, it is the Committee's view that an owner should be allowed to have the situation reviewed after 15 years and that a forest should be handed back only when certain conditions regarding its upkeep have been satisfied.

The Committee stresses the need of reafforestation, deals with the prevention and punishment of forest offences and proposes the levy of a forest conservation cess.

The Press Note says that, owing to the progressive destruction of the forests in parts of West Bengal, there is reason to believe that considerable areas of land are being affected by erosion and that this part of the Province is being rendered more liable to floods and drought, and that the supply of timber and fuel for the local people is being endangered.

The Committee was set up by the Bengal Government in July, 1938. The area of the inquiry comprised the districts of Bankura, Birbhum, Burdwan and Midnapore. The Committee was constituted of the Commissioner, Burdwan Division, as *ex officio* Chairman and 13 other members, of which three were officials and ten non-officials, among the latter being eight representative members of the Bengal Legislature.

The Committee has annexed to its report a rough draft Bill. There are 12 appendices and there is a note of dissent by one member, Rai Harendra Nath Chaudhuri.

The Committee recorded the evidence of 79 witnesses. Apart from the witnesses who were examined at the formal sittings held for the purpose, many were examined informally in the forests, where they illustrated their evidence by pointing to the condition of the trees and the soil.

In Part I of the Report the Committee has recorded a brief illustrative account of deforestation in other countries and the preventive measures taken in those countries. An attempt has been made to assess the causes and effects of erosion in India. Part II of the Report is devoted to the consideration of the causes and the extent of deforestation in Western Bengal.

PRIVATE OWNERS

The causes of mismanagement of forests by private owners have been discussed at length. There are, according to the Committee, two factors, which operate to make management by big forest owners defective; they lack technical knowledge and facilities for getting technical advice, and they are handicapped when they deal with forest offences by lack of powers such as are given to Forest Officers in the Forest Act.

The situation is far worse in the case of small owners. They cannot afford to keep an adequate staff, much less to employ any skilled managers; they rely on their own common sense and on local ideas as to forest management with regard to policy, and on a few ill-paid and usually part-time guards and on their own personal authority in the neighbourhood for the protection of their forests against theft and the intrusion of cattle. Economic pressure drives them to sell to contractors the right to cut their forest before the trees are fit to be felled. The forest is thus knowingly given up to ruin in order to meet pressing needs for ready money.

Failure to observe a proper rotation and failure to provide for regeneration are mistakes on the part of owners; but for the other wrongs done to destroy forests the owners are far less to blame than the people living near them.

First to be mentioned is the indiscriminate destruction of trees by villagers, either in the exercise of some right that is claimed, or by the way of unmitigated theft. Secondly, there is the custom of burning forest in order that ashes may be washed down from it on

to the neighbouring fields. Fires in forests at the end of the hot weather, when dead leaves and undergrowth are thoroughly dry, become intensely hot and not only damage young trees (especially young shoots) but also destroy the protective covering which prevents soil erosion.

Much damage is also done by indiscriminate grazing of cattle. The villagers deliberately and intentionally cause the cattle to graze in the parts of the forests where they will do most damage: their one object is to get the best grazing that they can for their cattle regardless of the amount of damage which may thus be caused to the forest.

Another harmful practice is that of digging up old stumps and burning them for charcoal. It would do a great deal of harm to dig up stumps, whether living or dead, especially on slopes, for it gives a start to erosion and encourages the deliberate killing of the trees.

NEED OF CONTROL

The Committee is convinced that control of some kind over the management of private forests is inevitable if their deterioration is to be retarded or remedied. In Part III of the Report the Committee has formulated its proposals for taking over such control.

The Committee considers that powers must be taken by legislation to compel every owner of a forest in Western Bengal to manage it in such a way as to prevent serious deterioration and consequent erosion; and that, if an owner will not or cannot do this, the Government should step in. It is not, however, thought either necessary or desirable that the Government should actually take over the management of all forests. A fair proportion of the larger forests is at present being managed well enough to avert deforestation and erosion, though not, as a rule, well enough to secure for the owners the fullest possible yield.

Those owners who are in a position to manage their forests properly, but have so far failed to do so through apathy or ignorance should, in the opinion of the Committee, be given a chance to show what they can do, and those who are managing their forests well already should be left to manage them still.

All alike should be assisted by being given expert advice and should to some extent be controlled. It seems to the Committee

that control could most conveniently be exercised by imposing on every owner an obligation to prepare, and to follow, for each of his forests a working plan such as has been found to be essential for the scientific management of forests in all parts of the world.

A working plan means a written scheme of management, aiming at a continuity of policy, controlling the treatment of a forest. The forest in respect of which a working plan has been approved has been called a "controlled forest." A Regional Forest Officer would be responsible for approving and modifying working plans and for preparing them in case of the owner's failure, an appeal lying to an Appellate Committee.

The whole object of a working plan would be baffled if owners felt free to depart from it at their pleasure, and it is, therefore, proposed that they would be liable to prosecution if they did so and that if they repeated the offence the Government would be able to step in and assume management.

As regards the release of the "vested" forests, it is generally provided that an owner should be allowed to have the situation reviewed after 15 years and that it should always be reviewed after 30 years, a period which normally should prove long enough for the forest to be restored to a reasonably good state.

Certain conditions would have to be satisfied before a forest is handed back to its owner: first, the Government must have been reimbursed in respect of all that had been advanced for the restoration and upkeep of the forest, and, secondly, there must be a reasonable prospect that the forest can be maintained in a satisfactory state.

In most cases the existence of a working plan and the knowledge that neglect could lead to prosecution and perhaps a further period of management by Government should be sufficient inducement to an owner to manage properly the forest when it is restored to him: and in most cases, therefore, forests would be handed back to their owners as a matter of course after 30 years.

As regards afforestation in Western Bengal, the Committee considers that it will be disastrous to leave as they are the areas from which forest has disappeared. Reafforestation is bound to be very slow if it has to wait till a deep soil has been built up.

It is, however, impossible to escape from the conclusion that experiments ought to be made with a view to working out a fairly cheap method of reafforestation. The Committee's proposals are that there should be provision for handing over the inferior cultivated lands on the edges of forests to the owners of those forests for afforestation in return for suitable compensation and subject to payment of rent to the landlords of the lands if these are not the owners of the forests, as they very often are; and that where it seems possible to afforest waste land the Government should be able to declare its control to be vested in a forest officer for a specified period. The release of the land to the owner would be considered after 15 years and 30 years as provided regarding vested forest.

It is recommended that the provisions regarding afforestation of waste land should be made applicable to waste land anywhere in Bengal.

As regards the prevention and punishment of forest offences most of the relevant provisions in the draft Bill annexed to the report are adapted from the Indian Forests Act.

The Committee, however, stresses the importance of the provision in clause 24 of the draft Bill for a collective fine on the inhabitants of any locality in the neighbourhood of a forest which is being seriously damaged with their connivance.

The Committee recognises the difficulty in getting convictions in respect of forest offences and proposes as a remedy the vesting of Regional Forest Officers with powers to compound these offences and the empowering of Forest Officers and the police to seize suspected forest produce. There would have to be, as well, sustained and systematic propaganda to instruct people as to the value of the forests to them and to the whole countryside.

LOANS FROM GOVERNMENT

The forest owners who gave evidence before the Committee represented that there was a likelihood of a fall in the income from forests during the early years of the new system, and that there was a risk that control would prevent them from cutting forest to meet emergent demands for money.

There is no escaping the conclusion, says the Committee, that the introduction of longer "rotations" will mean a considerable

though temporary loss of income, and it will be no consolation to the small owner to know that if a longer rotation had not been introduced he would quickly lose his whole forest and the income with it.

The Committee says that if a forest owner found himself hard pressed for funds, which, but for control or Government management he would have raised by the sale of forest produce, he should be allowed to apply for a loan from the Government. Normally this would be given him only to tide over the period between the introduction of control and the time when the forest became capable of the improved yield which would result from proper management; and it would be given on the security of the forest. The loans would be advanced by the Collector of the district as if they were land improvement loans, and the total of the loans given each year would be limited by the budget provision made.

The Committee also proposes the levy of a forest conservation cess. It is certain, says the Committee, that if an attempt was made to enforce payment for forest improvement before the improvement became manifest it would be highly unpopular throughout the province. The Committee, therefore, is strongly of opinion that it will be necessary for the Government at the outset to bear the cost of the Regional Forest Officers and of their staff.

There would have to be at least two Regional Forest Officers for Western Bengal, one dealing with Midnapore and with that part of Bankura which lies to the south of the river Dwarkeswar and the other with the rest of Bankura, Burdwan and Birbhum. Under each of these there would be two Range Officers. These would collect the data for the preparation of working plans for vested forests and for the check of those for the "controlled forests." They would also make the inspections necessary for seeing that there was no unauthorised departure from the plans, would deal with the prosecution and the compounding of forest offences and would supervise afforestation.

Under each of the Range Officers there would be two Beat Officers who would deal with the matters entrusted to Range Officers except that they would have no power to compound offences.

The Regional Forest Officer would be responsible for the general administration of the Forest Region, under the control of the

Conservator of Forests, and for the performance of all the functions which it is proposed in the Bill to assign to him including, in particular, the adoption of suitable working plans for every controlled and vested forest in his Region. The expenditure would be borne by the Government during the first 10 years during which control would lead to reduced incomes. After the tenth year the improvement in the condition of the forest ought to have led to an increase in the income from them, and it would then, in the opinion of the Committee, be fair to demand a return from the owners for the expert advice of which they would have had and would continue to have the benefit. The proposal of the Committee is that the cess should be charged on an acreage basis. If all the forests in the Western Bengal districts paid cess the incidence would be something like one anna or $1\frac{1}{2}$ annas per acre per annum.

As regards vested forests the proposal is that their maintenance and improvement should be financed by the Government. Any loss on the working of a forest in any year would be debited against the forest in the accounts and be recovered from future profits.—*The Statesman*, 12th January, 1940.

INTERPRETATION OF PLANT STRUCTURE*

By Professor D. Thoday,

University College, Bangor

Structure and Function.—Under the influence of Darwin's concept of "survival of the fittest," a tendency to assume all structural features to be adaptive was strengthened. It is, of course, essential that the structure of plant organs should enable them to carry out their functions adequately; but perfect adaptation of tissues to their functions would be difficult to define. The study of *xerophytes* provides an instructive example.

Before the physiological adaptation of plants to their environments can be properly assessed, we need far more exact knowledge regarding the quantitative relations of their different functions to

* From the Presidential Address to Section "K" (Botany) of the British Association, delivered at Dundee on September 1, 1939.

the environmental factors, and regarding the balancing of those functions. The question to be answered is not how an organ is adapted to its function, but rather *how its form and structure affect its functioning.* Quantitative investigation of the effects of minute structural features is often beset with great difficulty. We have not even yet reached finality in the solution of problems presented by stomatal diffusion, as affected by wind and other external conditions and by the size and proximity of the stomatal pores, although much intensive work has advanced our knowledge considerably; nor do we know just how much effect to attribute to the sinking or raising of stomata, or other special devices.

While the exact laws of the diffusion of gases through stomata are difficult to establish, it might be thought that the *distribution* of stomata at least would lend itself readily to adaptational interpretation. Actually, the facts point very largely in the reverse direction. Salisbury's statistical studies in particular have shown that, on the whole, plants in more exposed places have a higher stomatal frequency, and that for a given species the proportion of stomata to epidermal cells is more constant over a range of moisture conditions than stomatal frequency, variations in which are to be interpreted largely as the consequence of the different degrees of expansion subsequent to the initiation of the stomata. This turns the attention away from adaptation to the process of development. Salisbury's results indicate that stomatal frequency is determined by factors at work in two phases of leaf development. The first is the formative phase in which the position and number of stomata are determined in relation to epidermal cells, mainly by internal influences depending on the hereditary make-up of the plant. The second is the expansion phase, in which the degree of separation of the stomata, already initiated, is determined.

Goebel has shown how problems of development may be attacked inductively in his "Gesetzmassigkeiten im Blattaufbau." The general result of his studies of leaf development was to bring out the repetitive nature of the patterns that are laid down, the units of a pattern showing, at the time of initiation, remarkable constancy of scale. Thus, at the growing edge of a fern, frond bifurcation of the veins keeps their spacing within certain limits, just as the size of cells in meristems tends to remain more or less constant

owing to division when an upper limit is reached. The uniformity of size of the meshes in a net-veined leaf is a similar phenomenon which has been studied by Schuster. Stomata and also root-hair initial cells show an approximation to uniformity of spacing at their initiation, however much the fact may afterwards be obscured by expansion of cells between the initials, or inhibition of their further development. Kuster has emphasised the correlational aspect of such regularities, as depending upon mutual relations between the different tissues or structural elements that make up the pattern.

Another example of a quantitative approach to problems of adaptation is afforded by attempts to correlate the dimensions of parts served and tissues serving them. It is obvious that as the foliage of a tree increases in extent the amount of conducting tissue in the stem increases too; and that from the small twig through branches to the main trunk the amount increases parallel with the increasing number of leaves to be supplied. Jaccard directed attention to the quantitative aspect of this relation; and his pupil Rubel examined it in greater detail for the herbaceous plant, *Helianthus annuus*. Salisbury had already correlated the vascular structure of petioles with the dimensions of the leaf blades, with special reference to the xylem and transpiration. The correlations displayed were not exact and showed considerable variations. Yet they are remarkable enough, and especially worthy of note when we begin to inquire how such correlations come about. An interaction between one part and another is implied. This aspect has been investigated both experimentally and by anatomical analysis. Jost's classical experiments on Phaseolus seedlings (1893) showed that severance of leaf-trace bundles in the middle of an internode interrupted their development below the point of severance, but not above it, although neither part could function normally. In herbaceous plants, cambial activity at any given level often exhibits local variations which are related to active development of different leaves above. In the sunflower it is conspicuously shown. That the developing organs actually influence the growth of the stem below them, to considerable distances, is a natural inference. Strong support for the reality of such influences has been forthcoming from one of the most spectacular advances in knowledge in recent years—the dis-

covery of chemical agents controlling growth, which was an outcome of investigations on the curvature of shoots in response to light. The growth-promoting substances, called "auxins," are highy active. One fifty-millionth of a milligram produces a measurable effect on the oat coleoptile. They are produced specially by actively growing parts of shoots—sprouting buds, shoot-tips and young expanding leaves. They not only influence growth in length, but also produce other effects which are of greater interest in the present connexion.

It has been shown experimentally by Snow and confirmed by others that auxin stimulates cambial activity. Soding has actually detected auxin in the cambium of trees in spring and summer. He states that it appears there a little in advance of the resumption of cambial activity in the spring. Since it is produced by developing buds and young leaves and travels downwards, the downward spread of cambial activity from the base of the awakening buds in spring is thus accounted for in terms of an effect of auxin which is experimentally demonstrable. The basipetal conduction combined with tangential localisation exhibited in this instance gives strong support to the interpretation, already suggested, of the localised cambial activity in the intact sunflower stem, as indicating a causal influence proceeding downwards from the actively growing leaves. Evidence has also been adduced of stimulating agents of a chemical nature liberated from wounded tissues. The demonstration that such hormones exist and are effective in influencing plant development is of far-reaching significance. It is a challenge to students of plant structure to view their data dynamically. The statement that one part of a plant influences another is no longer to be understood merely as a convenient way of expressing a correlation, in a figurative sense, but is a legitimate hypothesis in a causal sense.

The Phyletic Outlook.—The evolution theory gave a new meaning to natural relationships, as revealed by the systematist, and a new aim to the systematist himself. Previously a natural system was conceived as a system of classification depending on the balance of similarities, estimated from a consideration of all the characters of a species, as compared with an artificial system depending on particular characters selected for their convenience. The ancestry

of species now became, in theory, the main basis for a natural classification.

It was soon realised that, as similarities in some features are often accompanied by dissimilarities in others, similarity might not always *signify relationship*. *Fossils themselves*, moreover, provided clear evidence that similar organs or structures have been evolved independently along different lines, by different phyla, so that the possession of seeds, for example, is not evidence of common ancestry for all seed-bearing plants.

Modern genetics reveal, as *the most prolific cause of variation*, irregularities in the process of nuclear division and the behaviour of the chromosomes, and changes in the substance or structure of the chromosomes which appear to be entirely erratic and haphazard.

If, however, we turn *from the minor variations which* differentiate species and horticultural varieties and survey the major events that have marked the evolution of plants, it is difficult to regard these as haphazard. Besides seeds, already mentioned, a number of features are found with even wider distribution, common to groups which cannot be traced to a common origin. Such are the alternation of sexual and asexual generations; archegonia; the formation of spores in tetrads, following a reduction division; air-space systems and stomata; vascular tissues; then fertilisation, evolved also in the animal kingdom, and the cell as the unit of construction; the nucleus with its chromosomes and their highly organised behaviour in division. The enumerations need not come to an end on the plane of cellular, structural organisation, *for chemical parallels are quite as remarkable. Consider, for* example, the similar enzymes and enzyme complexes responsible for carbohydrate metabolism in yeast, in the higher plant and in animal muscle; the hæmins found in plant and animal cells alike, and the related substances, chlorophyll in the green plant and hæmoglobin in animal blood, with uniquely important functions. Finally, there are the proteins and other important basal constituents of living matter.

The idea was suggested by F. F. Blackman in 1921, in reference to Nef's work on the interchangeability of carbohydrates, that the

biologically important carbohydrates are just those which are chemically most likely to arise—most readily formed, most stable, etc. May we not extend this idea to explain the universality of particular chemical compounds or radicals—like the aminoacids, limited in number, found in protoplasm?

The conditions for an epoch-making event like the arrival of chlorophyll were provided by the previous course of chemical evolution, in common characters of living matter, and by particular variants of them under particular conditions, which may have occurred but rarely in combination, but are scarcely to be envisaged as unique.

If it is legitimate to regard chemical events in this way, as occurring with a frequency concordant with their inherent probability, may we not carry this idea on to the higher plane of cellular organisation and structure? To do so is to direct attention to the nature of that stability and developmental harmony which are so conspicuous a feature of living organisms: for persistence and occurrence become more and more determined and limited by the pre-existing system through which evolution works. Natural selection of harmonious changes may have been more important than elimination of functionally unfit mature organisms. It is developmental harmony which is important, of which functional efficiency of adult organs is but a part.

We are thus once again led to the consideration of development. If we can obtain light on the laws of harmonious development, we may be in a better position to understand the nature of those major changes which the great pageant of evolution unfolds.

Seedling Structure.—As an example of the application of causal principles to old problems, I propose to consider the structure of seedlings.

The broad survey achieved by British workers revealed large differences within closely related groups, which made it more difficult to interpret resemblances as of phyllogenetic significance. A high degree of correlation was observed, on the one hand between the slender smallness of the seedlings and the diarch root structure, with two xylem poles extending right up the hypocotyl; and, on the other hand, between large diameter and tetrach or polyarch

structure, with stem-like pattern in the hypocotyl. Both Compton and T. G. Hill and de Fraine emphasised seed size as an important factor influencing seedling structure.

Another factor of a similar kind was the influence of the plumule, the traces from which, when precociously developed, shared with the cotyledon traces in the early structure of the hypocotyl. In certain cases, particularly among the *Amentiferæ*, the traces from the plumular leaves were found to be triads like those from the cotyledons (Davey, 1916), and these with their central xylem strand extend above the cotyledonary node into the epicotylar stem itself. Phyllogenists were inclined to interpret this as a more extensive persistence of primitive structure in a relatively primitive group. But the occurrence of the root-like solid core of xylem in the epicotyl of the *Vicieæ*, an advanced group among the *Leguminosæ* scarcely harmonises with phyletic ideas, as Compton pointed out, and makes phyllogenetic interpretations appear less certain.

Bugnon tried to approach the facts objectively, without phyletic aim or preconceptions, from the developmental point of view. As has been recognised since the work of Sanio, the differentiation of the leaf-trace bundles progresses basipetally from the node. Bugnon observed that in *Mercurialis annua*, as in many other plants, they normally fork into two, so avoiding incoming bundles immediately below, before uniting with other bundles lower down. The cotyledon traces likewise fork, though they do this sooner and in relation to the vascular system of the root.

Turning to the radicle, Bugnon notes that the root structure is quite typical. All other roots, however, arise from organs already differentiated. They form their own characteristic pattern of vascular arrangement, and this is linked by commissural elements to the appropriate tissues already present in the parent organ. In the case of the radicle, an exactly similar root apparatus has to be linked up, not with tissues fully differentiated, but with tissues still in a meristematic condition. The connecting tissues are therefore similar to ordinary conducting strands, not special commissural elements.

Bugnon did not, as far as I am aware, attempt to extend the same principles of interpretation to the wider range of facts which

have been brought to light, and it appears worth while to see how far this can be done.

In the first place, from a causal point of view, certain principles can be regarded as established. The first is the power of self-determination inherent in growing organs and especially in apical growing points—each developing a characteristic pattern of external form and internal structure. The second is the influence of apical developing organs on the structure of other parts still capable of growth—this applying particularly in the basipetal direction and, therefore, mainly to the influence of the shoot apex and young leaves on the parts below them.

With regard to the root, a spectacular demonstration of its power of self-determination has been provided by Philip R. White who, following on the pioneer work of Robbins and Maneval, succeeded in 1934 in proving that root-tips cut from the plant can be grown continuously for years in a nutrient solution containing the essential salts, sugar and a small concentration of an extract of yeast.

In the large adventitious roots of many monocotyledons, it is particularly evident that no relation exists between the pattern laid down in the root primordium and that already present in the stem to which it has to be connected. The repetitive nature of the pattern and its inherent stability also become more obvious. The alternation of exarch xylem strands with phloem strands, in a ribbon with definite radial polarity, expresses a harmonious balance of influences and developmental processes. The fundamental uniformity of the root pattern throughout the great majority of vascular plants is further evidence of this inherent stability.

To turn to the shoot: it will probably be admitted that the shoot apex is a self-determining and dominant centre of development. It controls the polarity of the shoot, and round it the repetitive pattern of leaf primordia unfolds. The apical bud as a whole controls also the primary development and secondary growth in the stem below. There is much in the system of relations exhibited which is reminiscent of the part played by organisers in the development of animal embryos.

In the determination of primary structure in the stem the leaf primordia play a predominant part. The number of vascular strands in the leaf base depends partly on hereditary factors, but partly on size. This is particularly clear in Monocotyledons, where the bundles arise in succession, separated by parenchyma, as the new leaf primordium extends round the apex.

Now in seedlings the conditions are unique. At two ends of a short meristematic axis are two self-determining centres of different kinds in close proximity, two opposite poles, a shoot-pole and a root-pole, each of which is capable of impressing its own inherent pattern on the meristematic tissues to which it gives rise. Under these conditions we cannot assume that the sphere of influence of each will be sharply defined, or that they will necessarily be fixed. If the influence of the poles depends on hormones emanating from them, the boundary might well change with changes in relative vigour of the two organising centres, and differ also from one species to another.

It appears reasonable, therefore, as a working hypothesis to interpret the structure of seedlings in the following way:

(1) The cotyledons and, if the plumule is precocious, the plumular primordia, influence the number of procambial strands in the hypocotyl and its diameter growth at an early formative stage. The form of the cotyledons plays a part. Nutritive and other factors afterwards affect the expansion of the hypocotyl and the degree of separation of the bundles by parenchyma.

(2) Differentiation within the strands of procambium is controlled initially by the root apex in the majority of cases, but to a variable distance upwards. The triad represents the smallest unit of the root pattern, existing as a detached arc, whether in the hypocotyl or a dorsiventral cotyledon.

(3) In the upper part of the seedling, sometimes only in the blade of the cotyledon, sometimes also in the petiole, or even lower, the shoot itself holds sway, and in place of a triad is found a single bundle. The intervening region is one of compromise and accommodation between the two patterns.

(4) With increasing activity of the shoot, further development is stimulated, from above downward, in the formation of centrifugal xylem on the inside of the phloem strands. These appear to be the main channels of the basipetal influence. In *Dicotyledons* the centrifugal xylem is commonly if not generally the result of cambial activity, which ultimately extends down into the root itself.

One factor in the determination of the relative preponderance of root and shoot is very probably the production of auxins by cotyledons and plumule.

We have seen how a substance of known composition, auxin, acts as an agent in the co-ordination of the different parts of a plant, but this does not mean that we can explain the activities that are co-ordinated. Great as have been the advances in biochemistry, we are not yet furnished with the means of expressing in physico-chemical terms the delicacy and subtlety of the adjustments exhibited even in plants.

Take, for example, the adhesive disk and haustorium of a mistletoe seedling. This remarkable organ is the result of a series of co-ordinated responses in the growth of the little green meristematic knob from which it arises. Contact pressure leads to one-sided growth, by which it brings itself face downwards on to the surface, to which it adheres with the aid of a special viscous material. There follows further growth of its now dome-shaped outer shell, the edge of which moves slowly outwards as the area of attachment widens. Under the dome, cells of the lower surface grow out as papillæ, which adhere closely to the epidermis or cork of the host twig. By the outward and upward movement of the growing shell and a contraction of tissue within it, the papillæ are lifted sideways and the adhering outer protective layer is torn up. Then new papillæ fasten themselves to the next cork layer and the tearing process is repeated. In this way several such layers may be picked up until a breach is made in the periderm, giving access to the living tissues within. Through this slit the wedge-shaped haustorium grows.

It is strikingly obvious, in a specialised organ such as this, where growth is closely and uniquely adjusted in response to a

particular environment and in relation to a peculiar, special mode of life, that structure and behaviour are interdependent. There is, however, no logical justification for neglecting to interpret the development of ordinary plant organs on similar lines. The main difference is that the cells respond chiefly to internal influences, though the organ as a whole exhibits tropic curvatures in response to appropriate external stimuli.

It is not possible to pursue this line of thought further; but reference should be made to the work that has already been done by Schuepp, Priestley, Adriance Foster, Helm, Gregoire, Snow, the veteran Schoute and many others towards the elucidation in detail of the course of differentiation in the shoot of *Dicotyledons* and *Monocotyledons*, from which is gradually emerging a better understanding of the principles of their developmental organisation.—*Nature*, Vol. 144, No. 3648, dated September 30, 1939.

The following information is taken from the statement relating to the

IMPORTS

ARTICLES	QUANTITY					
	Month of December			9 Months, 1st April to 31st December		
	1937	1938	1939	1937	1938	1939
Wood and Timber						
Teakwood—						
From Siam (cubic tons)	79	22	..	690	732	30
,, French Indo-China (cubic tons) ..	104	455	..	1,745	3,289	3,046
,, Burma (cubic tons)	14,154	14,044	16,956	1,20,053	1,17,158	1,17,649
,, Java (cubic tons)	14	..	..	3,622	2,382	2,460
,, Other countries (cubic tons) ..	93	..	..	612	20	..
Total ..	14,474	14,521	16,956	1,26,722	1,23,581	1,23,185
Other than Teak—						
Softwoods (cubic tons)	2,308	2,148	861	15,151	12,466	7,509
Matchwoods (cubic tons) ..	717	432	50	7,667	6,792	5,062
Total ..	3,025	2,580	911	22,818	19,258	12,571
Unspecified (value) ..	..	..	..	..	..	..
Firewood (tons) ..	36	.	33	451	558	389
Sandalwood (tons) ..	10	38	20	119	141	121
Sleepers of wood (tons)	4	29	10	641	277	1,216
Plywood (tons) ..	383	641	364	3,852	4,556	4,573
Manufactures of Wood and Timber—						
Furniture and Cabinetware ..	..	..	..	..	..	..
Other manufactures of wood (value) ..	..	..	..	..	..	..
Total of Wood and Timber (value) ..	..	..	..	..	..	..
Other Products of Wood and Timber—						
Wood pulp (cwt.) ..	19,281	19,058	17,656	1,54,246	2,13,119	1,21,850

Seaborne Trade and Navigation of British India for December, 1939:

IMPORTS

ARTICLES	VALUE (Rupees)					
	MONTH OF DECEMBER			9 MONTHS, 1ST APRIL TO 31ST DECEMBER		
	1937	1938	1939	1937	1938	1939
WOOD AND TIMBER						
Teakwood—						
From Siam ..	12,710	3,565	..	88,689	95,145	3,336
„ French Indo-China ..	12,515	53,526	..	2,01,225	3,98,402	3,30,406
„ Burma ..	18,75,460	18,11,992	19,85,070	1,53,88,835	1,55,11,286	1,49,20,284
„ Java ..	7,595	..	..	4,62,530	2,39,774	2,60,863
„ Other countries	10 547	..	..	67,986	2,501	..
Total ..	19,18,827	18,69,083	19,85,070	1,62,09,265	1,62,50,108	1,55,14,889
Other than Teak—						
Softwoods ..	1,69,553	1,74,845	63,924	11,44,119	8,93,261	5,12,853
Matchwoods ..	49,354	25,824	2,867	4,76,507	4,48,379	3,51,834
Total ..	2,18,907	2,00,669	66,791	16,20,626	13,41,640	8,64,687
Unspecified ..	2,80,493	3,11,631	2,73,900	19,91,471	24,08,678	20,11,343
Firewood ..	540	..	506	6,768	6,804	5,856
Sandalwood ..	1,489	7,054	4,211	34,988	34,905	34,274
Sleepers of wood ..	511	2,397	1,307	80,257	42,561	1,61,741
Plywood ..	94,881	1,29,572	87,165	8,28,368	9,57,362	8,83,531
Manufactures of Wood and Timber—						
Furniture and Cabinetware ..	1,43 948	1,08,739	66,685	17,01,275	12,32,636	9,73,599
Other manufactures of wood ..	1,00,511	1,03,251	73,651	13,30,623	12,18,362	10,80,102
Total of Wood and Timber ..	26,16,159	26,23,657	24,92,601	2,21,02,366	2,22,60,420	2,05,56,423
Other Products of Wood and Timber—						
Wood pulp ..	1,36,164	1,52,041	1,33,447	11,74,681	19,96,776	8,69,544

EXPORTS

ARTICLES	QUANTITY					
	MONTH OF DECEMBER			9 MONTHS, 1ST APRIL TO 31ST DECEMBER		
	1937	1938	1939	1937	1938	1939
WOOD AND TIMBER						
Teakwood (cubic tons)—						
To United Kingdom	..	..	..	207	37	20
,, Germany ..	..	..	..	..	1	..
,, Iraq ..	48	16	15	159	192	284
,, Ceylon ..	..	1	..	1	2	30
,, Union of South Africa ..	..	..	..	..	..	..
,, Portuguese East Africa ..	..	..	..	..	..	..
,, United States of America ..	..	..	..	..	..	..
,, Other countries	144	119	46	623	1,696	1,123
Total ..	192	136	61	990	1,928	1,457
Teak keys (tons) ..	..	..	..	..	..	..
Hardwoods other than teak (cubic tons) ..	..	..	..	15	..	..
Unspecified (value) ..	..	..	..	..	..	..
Firewood (tons) ..	1	..	..	116	..	2
Total ..	1	..	..	131	..	2
Sandalwood (tons)—						
To United Kingdom	..	..	..	14	11	..
,, Japan ..	..	..	20	54	43	71
,, United States of America ..	2	5	269	435	312	501
,, Other countries	27	33	25	265	138	223
Total ..	29	38	314	768	504	795
Manufactures of Wood and Timber—						
Furniture and Cabinetware (value)	..	..	..	..	..	..
Other Manufactures of Wood and Timber (value)	..	..	..	..	..	..
Total of Wood and Timber—	..	..	..	..	..	..

EXPORTS

ARTICLES	VALUE (RUPEES)					
	MONTH OF DECEMBER			9 MONTHS, 1ST APRIL TO 31ST DECEMBER		
	1937	1938	1939	1937	1938	1939
WOOD AND TIMBER						
Teakwood—						
To United Kingdom	..	..	..	28,166	4,719	2,600
„ Germany ..	..	..	..	..	150	..
„ Iraq ..	3,160	1,368	1,795	29,472	55,281	56,929
„ Ceylon ..	..	109	..	146	307	2,145
„ Union of South Africa ..	..	..	..	..	..	..
„ Portuguese East Africa ..	..	..	..	..	..	..
„ United States of America ..	..	..	..	..	..	..
„ Other countries	41,657	36,855	3,280	1,76,950	6,18,049	2,39,549
Total ..	44,817	38,332	5,075	2,34,734	6,78,506	3,01,223
Teak keys ..	..	..	..	..	..	..
Hardwoods other than teak ..	..	..	..	4,020	72	..
Unspecified ..	90,545	52,266	33,473	10,07,455	2,33,199	1,99,366
Firewood ..	8	..	..	1,035	..	16
Total ..	90,553	52.266	33,473	10,12,510	2,33,271	1,99.382
Sandalwood—						
To United Kingdom	..	..	..	14,680	12,380	..
„ Japan ..	..	130	20,000	51,610	45,283	74,025
„ United States of America ..	2,500	6,000	2,73,500	4,33,940	3,20,480	5,19,310
„ Other countries	29,195	26,910	24,695	2,65,722	1,31,543	2,10,529
Total ..	31,695	33,040	3,18,195	7,65,952	5,09,686	8,03,864
Manufactures of Wood and Timber—						
Furniture and Cabinetware ..	5,618	23,319	4,976	85,229	2,78,701	3,12,633
Other Manufactures of Wood and Timber ..	34,246	1,14,319	22,196	2,24,145	3,93,393	2,82,302
Total value of Wood and Timber ..	2,04,311	2,37,957	3,78,939	22,37,341	18,14,856	15,86,771

INDIAN FORESTER

APRIL 1940

SAL REGENERATION DE NOVO

By E. A. Smythies, C.I.E.

Discussion in the forest with various forest officers has indicated that my article on Sal Regeneration *De Novo*, published in the *Indian Forester* for October, 1939, requires clearer definition on several points.

(1) *Type of Forest.*—The conclusions and suggestions of that *article apply primarily to moist, good quality Bhabar Sal*, well stocked, and affected by evergreen invasion (*e.g.*, Clerodendron, Pogostemmon, Mallotus, Eugenia, *etc.*). To what extent it will apply to other types of sal forest is a matter of further experiment.

(2) *Shelterwood and Manipulation of Canopy.*—For the first stage in getting regeneration *De Novo*, I quoted the Working Plan Circle note as follows:

"A moderate opening of the canopy (this will probably mean nearly one crown's width space between the crowns of the seed bearers to be left, or, say, leaving the seed-bearers about 30 to 40 feet apart.)" I also mentioned my own preference for a "pepper pot" type of canopy. Consultation with other forest officers indicates the maximum amount of agreement on a canopy defined as follows:

A good "D" Grade thinning throughout as a matrix, suplemented by the prior existence or deliberate creation of permanent gaps, of a size corresponding to the crown space of one large mature dominant tree (or the equivalent in smaller trees), and not less than four such gaps per acre. These gaps act as foci or nuclei for bringing in and distributing the 50-50 mixture of light grass and evergreen considered essential for successful *De Novo* sal regeneration, and this canopy will not permit the undergrowth to get out of hand or become too vigorous for *De Novo* seedlings, if shrub cutting and burning are regularly carried out.

It must be emphasised, however, that this is the canopy for the first stage only. With the appearance of abundant small seedlings, a second felling becomes necessary, removing about a third of the existing canopy (followed, of course, by shrub-cutting and burning), to enable the small seedlings to develop into the large-leaf whippy stage. When this next stage has been developed in abundance (and this is often difficult to judge in actual practice), a fence is erected, burning is stopped, shrub cutting intensified, and the canopy further manipulated as follows:

(*a*) Where frost is not a danger, and where intensive Rains weeding can be guaranteed—*clear fell.*

(*b*) Where frost is a danger, a light shelterwood has to be left, preferably of middle storey miscellaneous species.

(*c*) Where Rains weeding is impossible and only Winter weeding can be undertaken - the third felling will remove about half the remaining canopy, leaving about 15 well grown trees per acre, followed after three or four years by a fourth or final felling over vigorous sal sapling crops.

In the Haldwani Division (particularly around Chorgalia) where this technique has been applied, it is now possible to see the complete range, from unfelled forest, with evergreen undergrowth, to established sapling or young pole crops up to 25 feet high, with nothing more to do except regular thinnings. In the series of six photographs in plates 9, 10 and 11, that illustrate this brief note, I have endeavoured to give some visual indication of the technique of canopy control and development of seedling regeneration.

(3) *Necessity for Frequent Inspections.*—I would emphasise that sal regeneration *De Novo* is an art and not a science, that every regeneration area at all stages up to the final one requires at least two thorough inspections every year, that rigid working plan prescriptions of fellings by fixed area coupes are impossible, as the canopy control and time and intensity of fellings depends essentially on the stage of the regeneration which no working plan officer can possibly foresee years ahead. The timing of the canopy control is also a most important factor; it is almost as bad to delay fellings too long as it is to make them too quickly. It is also necessary to realise that 100 per cent. success will seldom be realised,

(1)

Sela Compartment 6, Haldwani Division

Illustrates the forest before regeneration operations start. Fully stocked (but with occasional natural gaps) and much evergreen undergrowth.

January 6, 1940. *Photo: E. A. Smythies.*

(2)

Sela Compartments 3 and 5, Haldwani Division

First fellings completed, with evergreen invasion reduced by shrub-cutting and burning. (The foreground is rather more heavily felled than normal, due to the presence of advance regeneration.)

January 6, 1940. *Photo: E. A. Smythies.*

(3)

Sela Compartments 3 and 5, Haldwani Division

Second fellings completed. Note group of sal regeneration developing vigorously in foreground free of evergreen or grass suppression.

January 6, 1940. *Photo: E. A. Smythies.*

(4)

Sela Compartments 3 and 5, Haldwani Division

Third fellings completed. The area fully regenerated with sal 5 to 12 feet high. Note some natural semal regeneration also.

January 6, 1940. *Photo: E. A. Smythies.*

and in fact is not wanted. If we get 75 per cent. of a compartment regenerated with sal, and the remaining 25 per cent. with useful miscellaneous species, we are quite satisfied. We can usually mould the future crop to this mixture in the later stages of shrub cutting.

Another feature which necessitates frequent inspections is the astonishing velocity with which the sal regeneration develops, once it starts to go. The crops illustrated in photographs Nos. 5 and 6 are typical. Mr. Hall, who saw these particular areas with me in 1932, described his remembrance of No. 5 area then as "knee-high sal regeneration swamped by weeds." His surprise in 1940 at walking under dense young pole crops 20 feet high and over in urgent need of thinning was very natural. Mr. Howard, who originally fenced this area, was equally surprised and gratified. But such development is only possible with very heavy felling over abundant whippy growth, fellings that a certain school of silviculture refused to consider a few years ago. And perhaps quite naturally, as the province is dotted with "failed P.B.I." areas in which one or more of the three vital factors (canopy, weeds and deer) were neglected. It is interesting to note that in some of the P.B.I. areas of Haldwani Division, where there is a volume yield, there are indications that the sal regeneration is going to get ahead of the fellings permitted and that before we have covered P.B.I. with 1st and 2nd fellings, earlier areas will be clamouring for third and fourth fellings. And only eight years ago, some forest officers were urging the abandonment of the conversion to uniform method for these sal forests, owing to the numerous failed P.B.I. areas! I think this is a most gratifying result of research since 1932 and I should like to record that although the Research Branch are cautious and conservative in publishing results, the territorial staff have not waited for published statistical proof, but seeing the success that was developing in silvicultural research experiments, have gone and done likewise on the working plan scale with equally good results. For this the Research Branch deserve full credit, as having pointed the way.

(4) *Necessity for Looking Ahead.*—From what has been written above, it is evident that something more than working plan prescriptions for a 10 or 15-year period is required. In Haldwani Mr. Champion and I in 1936 prepared a four-year scheme that has

been quite successful. and is now nearly complete. Short-term planning on these lines is clearly advisable, in which the annual treatment of every compartment in P.B.I. should be suggested. This should include not only fellings but also shrub-cutting, burning, fencing, etc.

This note, which started off as a sort of supplement to my article on Sal Regeneration *De Novo*, appears to have branched off into a summary of the whole range of technique of natural sal seedling regeneration from start to finish. The point I would particularly emphasise is that the correct technique must be carried out with continuous unremitting attention all over P.B.I. guided by short-term planning of carefully prepared three or four-year schemes. Only by this means can final success be assured.

NOTE BY W. T. H.

In his article in the *Indian Forester* for October, Smythies declared it would be his last but I have persuaded him to write the above note to clear up one or two points which I found somewhat indefinite.

I have had nothing to do with these sal regeneration experiments but I have been an interested observer, having visited them four times at long intervals. In 1932 I struggled through a compartment containing plenty of sal regeneration two feet high but swamped by weeds. Under such conditions one is apt to observe the weeds more than the regeneration! The other day I walked through part of the same compartment and the same regeneration consisted of dense young saplings up to 25 feet high! To me this seems nothing short of miraculous as it is not so many years ago when the whole problem seemed to baffle the best brains in the service.

When Trevor came from the Punjab to the U.P. as an acknowledged expert in regeneration of conifers, he advocated what we then considered were heavy fellings over young sal regeneration. I carried out such regeneration fellings myself and the result was a mass of heavy evergreen undergrowth, disappointment and criticism. The severity of these fellings did not even approach what Smythies practises now over similar regeneration but we did not know his

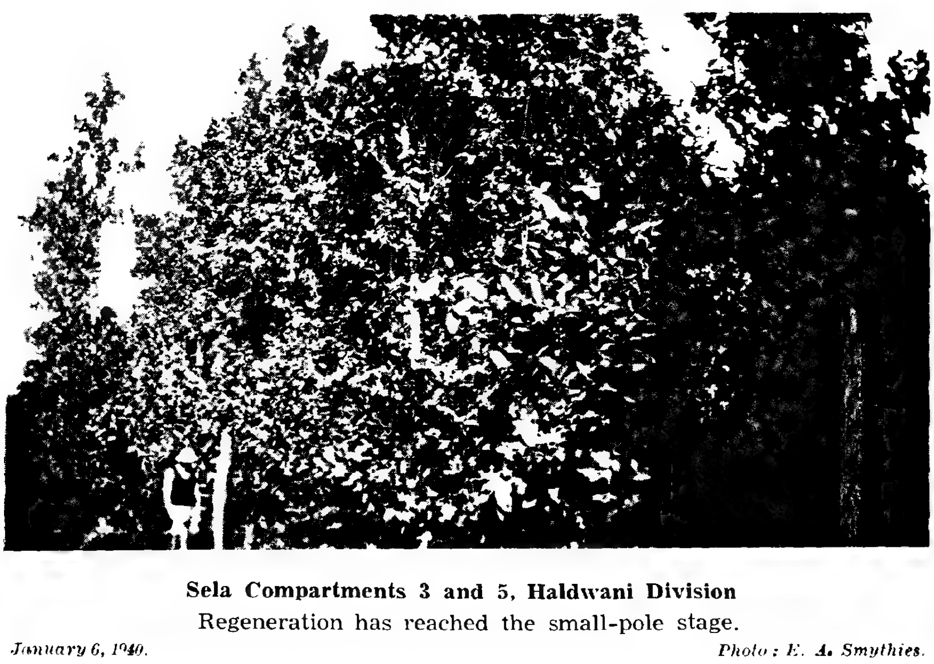
(5)

Sela Compartments 3 and 5, Haldwani Division

Final felling completed and fence removed. Regeneration 10 to 20 feet high.

January 6, 1940. *Photo: E. A. Smythies.*

(6)



Sela Compartments 3 and 5, Haldwani Division

Regeneration has reached the small-pole stage.

January 6, 1940. *Photo: E. A. Smythies.*

subsequent technique, since proved and demonstrated on a working-plan scale in moist Bhabar sal.

When I saw these areas in 1937, I was convinced that Smythies had solved the Third Stage of the problem, *viz.*, converting unestablished sal regeneration two feet high to well established young sapling crops 10 feet high by heavy fellings and shrub-cutting combined with protection from fire and browsing. On this occasion (January, 1940), I was therefore more interested in a large-scale demonstration of the *De Novo* stage and particularly what more exactly was considered to be the end of Stage Two, when conditions were such that burning should cease, a fence erected, a clear felling or very heavy felling carried out, and resorting to rains weeding if possible and at least to winter weeding. Actually, of course, it is impossible to be exact but it appears to be much easier to come to a decision in the forest than one would suppose. I would also like to emphasise here that *if rains weeding is impossible, you cannot resort to a clear felling* at this stage. It is much too dangerous, and if there is any fear of the weeds getting out of control, I would personally always remove the overwood in two operations instead of one when in doubt.

I think that as far as moist Bhabar sal conditions are concerned, Smythies has now also demonstrated the solution of the difficult *De Novo* stage; in other words, he can induce, keep and develop sal recruitment to the Whippy Stage after which the technique has already been fully proved over a sufficiently long period.

The whole technique requires careful modification for other sal types and even for Bhabar conditions the *De Novo* Stage may be subject to improvement. For instance, Smythies (and most other officers) are convinced that the first regeneration felling should be quite heavy—what Smythies refers to as a "pepper-pot" canopy and which he defines more closely in the article above. They are probably correct but I am not yet convinced that such a heavy initial felling is *essential* and, of course, some variation may be necessary in a drier type of forest. Then, again, Davis (whose note is quoted in the October article) definitely states that it will be generally advisable to fire-protect for one or possibly two years after a good seedling year. Smythies (and others) are, however, fairly

emphatic that we should continue to burn annually whether it is a good seedling year or not.

The regeneration interval may be fairly long (15 to 20 years) and costs of shrub-cutting (throughout) alone may be fairly high (Rs. 30 per acre) but this cannot be considered excessive. After a heavy felling the evergreen undergrowth may be exceedingly high and dense. Mr. Bailey informed us that before the winter shrub-cutting in one compartment he could scarcely put his elephant through it in places. Any improvements which result in the reduction of the regeneration interval and of the costs will be welcomed by all.

However that may be, we can now bestow on Smythies the title *Solver of the Sal Regeneration Problem.* He goes in March. On his retirement he could not have desired a greater reward.

ADDITIONAL NOTE BY E. A. SMYTHIES

While greatly appreciating W. T. H.'s flattering remarks on my work on sal regeneration. I hasten to point out that there have been many contributors to the solution of the problem. Hole's invaluable pioneer work was of an earlier generation. but during the last decade alone there have been contributions from many workers in the United Provinces. Howard evolved and erected the first deer-proof fence. Champion's summary of the All-India Sal Tour in 1933 was essential and most illuminating. Mobbs established the powerful influence of *rains* shrub-cutting in eradicating or controlling evergreen. and Raynor's later research experiments in the *De Novo* Stage have been invaluable. Amongst Divisional Forest Officers. Stewart. Champion and Davis in Haldwani. Hopkins in the Terai and Bhabar. Sen in Ramnagar. bravely applied on the working plan scale the new ideas of treatment that were being evolved. and confirmed their correctness I was very fortunate in having the opportunity of a wider and more *continuous* vision (over a period of many years) of our attempts to solve the problem than falls to the lot of the average forest officer. and was. therefore, in a better position to suggest modifications. to co-ordinate results and to spread the gospel of natural sal regeneration. I was also fortunate in that, having pledged my reputation (in 1932-33) on results. the results have proved satisfactory and redeemed my

pledge! But the solution has been the result of fine team work, and not of an individual, and so I must disclaim the honorary title that W. T. H. suggests, but I am glad to have been a member of a team, which, as the names given above prove, was exceptionally strong in silvicultural knowledge, and doubly glad that we have again hopefully raised the flag of natural sal regeneration before I retire.

PLANNING THE COUNTRYSIDE

[Being the text of a lecture delivered at Hazaribagh (Bihar) by Mr. J. W. Houlton, I.C.S., C.I.E., *Deputy Commissioner, Hazaribagh, and formerly Revenue (Forest) Secretary to the Government of Bihar.]*

When I began to think about this lecture on "planning the country-side" which I had rashly promised to deliver in response to the kind invitation of the Principal, I began to realise firstly the vast scope and complexity of the subject, and secondly how ill-equipped I am to deal with it. But in spite of that handicap I hope to be able to do some good by arousing your interest and perhaps stimulating some of my hearers to carry out research into certain problems of incalculable importance to the people of the country.

I am going to keep in view mainly our district of Hazaribagh, because, as the administrative head of that district, its problems concern me closely and because it has difficulties and also possibilities which are different from any other part of India.

Town planning is a science which has made great strides. Provision is made for streets of a proper width, for adequate and well-situated open spaces, for health and recreation, for proper drainage, sanitation and a hundred and one other matters. But what has been done for the planning of the country-side? The answer is almost nil. The country has been developed without any guiding plan. Now supposing that some benevolent Hitler (if such a being can be imagined) could have cast his eye a couple of hundred years ago on a tract of virgin forest and wilderness in a typical part of Chota Nagpur. Some thousands of his subjects are seeking for fresh fields and pastures new. Instead of setting up a brand new internment camp, our benevolent leader might proceed to lay out the country to the best advantage. He would direct that

the valleys may be cleared and brought under cultivation. Strict orders would be passed that the steep hills must be left untouched. No cutting of trees on such hills would be allowed, except under orders of the experts and with the object of improving the forest. On less steep hills forest would also be preserved, and the people would get their timber for building, for furniture and agricultural implements from those forests, under the guidance of the experts, so that the forest would continue to yield its harvest for future generations. Some of the more gentle slopes would be set aside as grazing grounds, and the people would be instructed how to make the best use of these grounds and prevent them from deteriorating. Other experts would select sites for reservoirs and would lay out irrigation systems. Healthy sites would be selected for the settlers to build their houses and the *bastis* would be built on approved plans. Groves for shade for the cattle and fruit orchards would be planned. Needless to say, proper arrangements would be made for good drinking water and for sanitation. And so our chancellor would have created a country-side beautiful with its forest-clad hills and its fertile valleys, its shady groves and its blue lakes; a country inhabited by a happy, contented and healthy people; a country where never are heard "ancestral voices prophesying war," where communal strife is unknown and the word politics is not found in the local dictionary. But perhaps imagination is leading me now too far into the realms of fantasy.

Well, ladies and gentlemen, we cannot put back the clock. Unfortunately, history presents a picture very different from the fanciful scene which I have just depicted. All over the world the forests have yielded to the attack of the pioneer, an attack which began with the dawn of pastoral life 10,000 years ago and has never ceased. In India vast areas were still untouched by the axe until recent times. For most of them their fate was sealed by two factors, the rapid increase in the population and the coming of the railways. There was no hand to guide the wielder of the axe and the cutting went on with no thought for the future. Warnings of the danger were given as early as 1827 by experts who toured the forests of Southern India. Mr. Connolly, Collector of Malabar, saw the danger of depletion of the teak forests in his jurisdiction and he founded in 1842 the famous Nilambar Teak Plantation. But it

was not until 1885 that a definite policy was laid down. In that year the Governor-General, Lord Dalhousie, laid down a clear and far-sighted policy of preservation of forests. India indeed owes a debt of gratitude to that great Viceroy. There is no doubt that action was taken in the nick of time. Since that year 100,000 square miles of forests have been placed under control and form an asset of immense value to the state. In our own province, unfortunately, the area so protected is very small. The first steps were taken in the year 1870. We have, in the whole province, only about 1,200 square miles of reserved forest, most of it in Singhbhum. In our own district only 250 square miles are reserved, though about 3,500 square miles of the district are still covered with some sort of forest.

Now I should like to say something about the work and lives of the officers of the forest services. Few people realise the devoted service which they are rendering to the country. They tour for months at a time in the vast and lonely forests. Their lives are devoted to improving, fostering and working the forests committed to their charge. They never see the ultimate fruits of their labour, for the harvest of the forest is reaped only at intervals of very many years, and the forest officer must make plans the results of which will be seen long after he has ceased to have any interest in forests. In the meantime, he must see that the tax-payer gets the best value out of the state forests, while using his knowledge and skill to ensure that the forest will endure, and continue to yield a profit to the state in the far distant future. The forest service must work for posterity, which means that it demands from its members more than in the case of any other Service—really conscientious work and sincerity of purpose. It may be easy to show a fine annual profit by adopting unsound methods of forest working. But you would have to go a long way to find a forest officer who would sacrifice his principles to obtain immediate personal credit. I have a great admiration for the work of the Forest Department, and I wish they would advertise themselves more and give the public an idea of the valuable work which they are doing.

The 3,250 square miles of unreserved forest in this district are at the mercy of impoverished landlords, destructive timber contractors and reckless and uninstructed tenants. Millions of valuable

sal saplings are cut down annually for fencing and fuel. In one village I estimated that 40,000 sal saplings were cut down last year. Nearly every *ryot* ekes out his living by selling wood in the markets and to dealers. Thousands of tons of timber of all kinds are sent out of the district annually by contractors, and the rumble of timber-laden carts is heard day and night on most of the roads in the district. Trees are cut down in the most wasteful way, three or four feet from the ground. (Sal trees should always be cut close to the ground.) Such is the ignorance of some landlords in this district that they stipulate in agreements with contractors that the trees must be cut not *less* than three feet from the ground. The very brushwood is cut down and even loaded into lorries. Great areas of sal forest have succumbed to this treatment, and thorn-bush jungle has taken its place, while the steep hill-sides are losing their soil and are turning into bare rock. Every hot weather fire rages through the forests. Sometimes the fires are due to carelessness and sometimes to deliberate setting of fire by ignorant people who think that the grazing is improved. Here let me quote from a letter sent to me by my friend, Mr. Sabharwal, Conservator of Forests in this Province, with whom I have had many illuminating talks on the subjects which we are now discussing. He says: "The products of the forest are absolutely essential to our national welfare. You would not set fire to your home, you would not set fire anywhere near a city and leave it. Why do so in the forest? A forest fire is waste of the worst kind. We have heard much of waste in industry. Forest fires mean waste which effects the cornerstone of all industry in our land." I was told by a forest officer that if any other species of tree, except the sal, which has such tremendous vitality, had been the prevailing species in this part of India, Chota Nagpur would long ago have become a treeless zone.

In the meantime the springs are drying up all over the district, wells dry up earlier every year, many cattle die of starvation in the hot weather and cultivation itself is deteriorating, especially in the dry uplands. To add to our troubles, lantana (*phutus*), is rapidly invading the forests and even the cultivated lands and ravine formations are extending into the cultivation.

Now, as you know, most of the forests in the district belong to private landlords. They have not the technical knowledge to

make the best use of their forests, and our old friend, financial stringency, often makes them sign the death-warrant of the trees. Sometimes the stringency is not merely financial. One landlord (not in this district) is said to have sold his forest for a bottle of brandy. A bottle of brandy is no doubt worth having, especially in these hard times, but the forest was worth a great deal more. Perhaps it was a dry area. Landlords can apply under the Forest Act to have their forests managed by government. Many have done so. Others hold back because they think that they will not get much profit under government management. To answer this objection, let me quote the case of the Porahat Forests which were retained under the management of the Forest Department when that estate was handed over to the proprietor some 30 years ago. In 1911 the forests showed over a five year period a surplus of Rs. 41,000. In 1921 the figure was Rs. 3,05,000 or over Rs. 60,000 a year, all of which was handed over to the proprietor.

In England forests often yield a profit of 50 rupees an acre. A profit of Rs. 15 to 20 an acre could be obtained in time from many of our forests if properly managed. Under the present lack of system, many of the private forests soon reach a stage when they yield nothing.

Here let me quote again from Mr. Sabharwal: "The time has long passed," he writes, "when we could subscribe to the theory of rugged individualism, whereby a land-owner can do anything he wishes with his soil. We are gradually becoming aware that the land-owner is, in fact, only a custodian and should be normally obliged to pass on his land, with its basic soil value unimpaired, for the future benefit of mankind. This theory may sound utopian, but, as a matter of fact, it is only hard commonsense based upon national self-preservation."

That part of our planning scheme which concerns the saving and improvement of existing forests is bound to meet with opposition at first from the *ryots*. They are beginning to realise the situation, but much more propaganda and education are needed to make them see that this work is in their interests and those of their children. At present they cut sal trees for fencing. They should be taught to plant hedges instead. That requires hard

work and patience, and some of them will ask why they should not do what their forefathers have been doing for years. We must convince them that the forests were much more extensive and contained far more trees and saplings and the population was smaller in the time of their forefathers. The problem of sale is more serious. At first hardship will be felt, for cutting firewood and taking it to the market is a simple and congenial job, and sal trees are easy to cut and make good fuel. But when the forests are reserved, consider the wealth that will pour into the country-side in all sorts of ways: there will, for one thing, be a big demand for labour in connection with the forests and many connected industries will grow up. We must tide over the interim period until the forests have recovered from generations of maltreatment with tact and understanding of the difficulties of the tenants.

Everyone knows that the population of India is increasing. In some parts of Chota Nagpur, especially those inhabited by aboriginal tribes, this increase is very rapid. The process of clearing land for cultivation is still going on in the less developed parts of southern Chota Nagpur, and in the Santal Parganas and elsewhere. The pressure of the population and land-hunger are strong, driving forces. Unfortunately, the land grows steadily less productive. At first the soil on the hillsides, held together since before the dawn of history by the forests which have now been cut down, yields good crops. But the deadly processes of erosion and drying up reduce the productivity of the land, and, after some years, many of the fields have to be abandoned while others yield an annually decreasing crop. I have myself watched this process of deterioration in the South Khunti hills in the Ranchi District and in the Santal Parganas. To recall for a moment our Utopia, the country developed on those lines could support a far greater population than it can ever do now. This is a very serious state of affairs if it is allowed to go on: and unless the birth-rate is reduced immediately and drastically—and that is not likely to happen—we must expect a decline in the standard of living, already—for the majority—extremely low, of the people of Chota Nagpur.

Now before discussing remedies for this state of affairs, I want to lay stress on the need for a combined plan, for a ministry, so to

speak, of all the talents. Forestry, it has been said, is the hand maid of agriculture. In the Punjab, which gives the lead to India in so many matters—*I am not referring* to politics—this has been realised for many years. In the U. P. also a five-year plan was introduced some years ago to provide better fodder and grazing for the 40 millions of domestic animals in the province, and the committee consisted of forest experts, agricultural experts, veterinary experts and revenue experts, besides non-officials. We must get away from the old bad habit of keeping forestry and agriculture and animal husbandry in separate water-tight compartments. I suggest that we want a strong Board of rural economy composed mainly of experts, as in the U. P. Committee, to tackle the task of making better use of land, the improvement of agriculture and of grazing, the afforestation of waste lands and the preservation of existing forests. The advice of geologists must not be overlooked. There is much that they can tell us about the nature of the rocks and of soils on this Chota Nagpur Plateau.

Now a few words about the consequences of disforestation. History has some examples which must give food for thought. Forests, it has been said, precede populations, and deserts follow them. By destroying their forests the peoples of ancient Persia and Babylon destroyed themselves. But the most terrible example in our time is the Yellow River in China. That is not a case of the land turning to desert—it is worse. For hundreds of years the Yellow River has gone on depositing its silt, the age old soil washed down from the hills, on to its bed. The industrious Chinese have gone on raising its banks, until the river breaks down its banks and on more than one occasion, it has turned the vast and densely populated country into a huge lake in which millions of people and countless cattle have been drowned.

The great rivers which flow past Cuttack seem to be silting up in the same way as the Yellow River. In America the effects have been different, but almost as disastrous. Thousands of square miles have been changed from fertile fields into sandy deserts, and the authorities are spending great sums of money in planting belts of trees to stop the advance of the desert. The "advance of the desert" was referred to in a lecture given in Patna a few years ago by Dr. Radha Kamal Mukharjee, Professor in Economics at the

University of Lucknow. Dr. Mukharjee was referring to the eastward advance of desert conditions through the Agra and Etawah regions of the U. P. where the population is declining and desert plants are appearing. His warning applied to this province also, and warnings have been issued by our own forest experts that there are unmistakable signs in parts of Chota Nagpur of the coming of desert conditions, signs such as the appearance of desert grasses on land denuded of its surface soil. The disforestation of the catchment areas of the great rivers which flow down from the hills into Bihar, Orissa and Bengal leads to increasingly disastrous floods.

Now experiments have been carried out to show the actual amount of erosion which takes place on different types of land, and the results are of very great interest. Experiments in the run-off of water by the Punjab Irrigation Research Institute show that the soil carried away by the water on 32 wet days was:

From land almost entirely covered with grass and bushes	5 per cent.
From land fairly well covered with grass	7 per cent.
From bare soil, on which the grass is clipped or grazed every three days ...	25 per cent.

The weight of soil lost from the first two classes was 3,800 lbs. and 3,900 lbs., and for the bare grazed soil 18,500 lbs. per acre. In one bad storm the bare land lost $1\frac{1}{2}$ tons per acre. The loss from unterraced and badly cultivated land on slopes is worse still. One *jawar* plot lost 115 tons of soil per acre, largely as a result of two bad storms. This illustrates the harm done by cultivating sloping lands without terracing. Then take the run-off of water.

Twenty times as much water runs off disforested and heavily grazed land as from forest covered land. Can you wonder that the wells in Hazaribagh dry up so soon and that the springs which used to water our fields have disappeared? One other interesting point: the time-honoured Indian system of small terraced rice fields is far better in the long run, except on flat land, than the big American fields cultivated by tractors, for the small fields retain their soil, and in the big fields there is a serious annual loss of soil

Now why do forests hold up water? In a few words, the explanation is that the surface soil is soft and loose, unless it has been stamped hard by grazing in the rains, and the roots of the trees, helped by burrowing animals, penetrate the compact layer of soil which lies some feet below the surface, and gradually break up the underlying rock. Forests form a huge subterranean reservoir of water. In a district like this, where rainfall is low, this is of very great importance to agriculture. Now, on bare eroded land, the water never gets through the hard upper layer. The facts have been realised by practical people whose interest in forests is small. No one would accuse the hard-headed citizens of Manchester of romantic ideas. They are practical men. They have found it necessary to spend a lot of money on afforesting the catchment areas from which the water is drawn for the reservoirs for the water supply of their city. In Chota Nagpur the eroded soil has a peculiarity, which you must all have noticed, of sometimes forming a hard rock like surface on which nothing grows and which no water can penetrate.

Another fact about eroded soil: soil in its natural state is rich in nitrogen, lime, phosphoric acid and other ingredient chemicals. Eroded soil is poor in these elements. The chemical value of grasses cut from the foothills has also been examined (also in the Punjab). On eroded soil, the grass is deficient in nitrogen, phosphorus and calcium, and is of much less nutritious value than grass from non-eroded soil.

Now let us turn to what can be done, and what has been done, to undo the harm done by disforestation and erosion. First of all, afforestation. I have already mentioned Mr. Connolly's Nilambar plantation. The Forest Department has taken up many others which I may briefly describe. The first followed on an important resolution issued by Sir John Hewett, M.P., in the year 1912. Along the Jumna and Chamba rivers there are vast areas of useless ravine lands, caused by erosion following on the destruction of the forests. The scheme evolved some 30,000 acres of this land. The surface soil was broken up and small dams and ditches were made to hold up the rain-water, and seeds of trees, mainly *sissu* and *babul*, were sown. The results surpassed all expectations. In six years some of the *sissu* trees attained a height of 50 feet. Huge quantities of

grass were produced. In 1922, 9,000 tons of grass were obtained from 5,000 acres of the plantations. This land was practically a desert before the scheme was started.

In the plains of the Punjab a scheme of a different nature has been carried out. There the trees are irrigated, and they have something like 60,000 acres of such irrigated plantations. An idea of the value of the scheme can be obtained from the fact that in one plantation of 9,000 acres some years ago the annual net profit was over Rs. 2,50,000, or nearly 30 rupees an acre.

In the Nilgiris about 60 years ago plantations of eucalyptus trees—trees with which we in Hazaribagh are familiar—were started to meet a shortage of firewood and small poles. They have been an enormous success, and the supply now exceeds the demand.

In Orissa I may mention, among other schemes, the Casuarina plantations, started in 1916, which keep out the seas and sand, and protects the crops and villages from stormy sea-winds and yield a valuable supply of firewood. Then, in Puri, much success has been attained with the teak plantations.

Many such schemes have been introduced in foreign countries. The most famous is the afforestation of the sandy tracts in France along the Bay of Biscay, started over a hundred years ago. The pine forests so started are now among the most valuable forests in Europe.

In our own province the Forest Department has been handicapped by lack of funds for afforestation and, consequently, their experiments are on a smaller scale than in some other provinces. There is huge scope for experiment and enterprise. In Hazaribagh District we want to find out the best methods, and the best varieties of trees, for afforesting four main types of land: rocky and denuded hills, ravines, bush forest and bare waste land. As you know, we have started certain experiments in afforestation there, where all these types of land can be found. I would explain that our district is far more suitable for these tasks than any other in Chota Nagpur. In Singhbhum they already have over about 900 square miles of reserved forest and 400 of protected forest. In Palamau there are extensive reserved forests. In Ranchi and Manbhum, apart from a few areas, the forests have, long ago, disappeared, and what forests there are are now honeycombed with cultivation. But here we still

have huge areas of continuous forest and most of forest areas are not suitable for cultivation. Hazaribagh district should form a huge timber depot for Bihar and Bengal. The forests should be a source of prosperity to the people of the district and of great benefit to cultivation. That is far from being the present position. But there is no reason why it should not be attained even now.

Quite as important as the need for afforestation is the need for improvement of grazing lands. I have already referred to the grave lack of fodder for the cattle in the dry weather in the district. In some parts of India the position is even worse. In one part of the Agra District in one year, a year of famine, 200,000 cattle died of starvation. Things are getting worse here, and the problem should be tackled without delay. What can we do? There are two ways of tackling the problem. Firstly, we must improve the grazing lands, and, secondly, the owners of cattle must be taught to store fodder for use in the dry weather. Grazing lands can be improved by trenching, and by rotational grazing. Left ungrazed for two years, both the quantity and the quality of grass improve. But it is not easy to induce the cultivator to leave a piece of grazing land alone for two years or even one year, and unless it is fenced it is almost impossible. However, education and example may do a lot. They have suceeded in other provinces. In the Punjab the system of closing areas to grazing and grass-cutting has been carried out under special officers of the Forest Department and the scheme now covers over 60,000 acres.

Now about storing fodder: I doubt if there is any other country in the world where a large proportion of the owners of cattle make no proper provision for feeding them and leave them to depend almost entirely on grazing. People should, in my opinion, be compelled by law to take reasonable measures for feeding their cattle. If legal sanction is impracticable, then we must rely on propaganda and example. Grass can be cut at the end of the rains and dried for hay, or it can be stored green in silo pits. I have no time to describe these silo pits in detail, but they offer perhaps the best solution of the fodder problem. At Sitagarha near Hazaribagh the Mission Fathers with their usual skill have brought the silo system to a high degree of efficiency. In three pits they have something like a hundred tons of excellent fodder.

made from chopped-up maize leaves and stalks. I saw one opened two days ago and I found the fodder coming out in first-class condition and it will be just as good in five or six months' time. This Sitagarha Farm is indeed an object-lesson to us all. A malarious wilderness has been converted into a flourishing farm where valuable crops are grown, hay is cut and stored by the ton, vegetables and fruits are grown in large quantities, trees are planted and a cheap irrigation system, with pipes made by the local potters, has been developed. This irrigation system is perhaps the most interesting thing in the farm and it may furnish the solution to the vital irrigation problem of Chota Nagpur. The pipe-line costs something like one anna a yard and is working beautifully.

On the subject of improvement of agriculture, I do not know enough to say anything. Anyhow the subject is so vast that it would be absurd for me to attempt here any sort of description of what has been and is being done. An immense amount of work has been done by the Imperial Council of Agricultural Research, though I suppose that 90 per cent. of the people of this Province have never heard of it. Many volumes have been written on the subject and our Viceroy was himself the Chairman of the Royal Commission on Agriculture in India which made a close examination of the problems and made many valuable suggestions. I would only say that our plan of making the best use of the country-side must include schemes for helping the *ryot* to get more out of his land.

The upland fields in this District are, for the most part, very roughly cultivated and produce crops of insignificant value. This is not all the fault of the land, for really good cultivators like the *Koeris* make the land pay well. They should be persuaded to grow money crops, to go in for vegetable-growing, to make more use of *kachcha* wells and to cultivate fruit trees. How many of the hundreds of thousands of *ryots* in this District grow fruit trees round their *bari* lands? Not many. It requires a little enterprise, a little patience and some work. But for a great part of the year, time hangs heavy on the hands of most of the *ryots*. I see no reason whatever why the average *ryot* should not pay his rent out of the sale of fruit and have plenty for his own use also.

Lime trees are paying trees and there are many others. For the improvement of the yield of the land, irrigation and machinery are the essentials. This Chota Nagpur Upland requires artificial manure of the right kind, and it would be a great boon if it could be made available to the *ryots* at prices which they could afford. I am a believer in the force of example and if one good cultivator in each village or group of villages could be taught to maintain a model farm with the help and advice of government experts and with some financial aid, there would soon be a general improvement throughout the country. I do not mean merely the demonstrating of crops and seeds and methods of growing them. I mean also irrigation by the best available means, hedge-growing, hay-making, siloing and anything else which conditions in our district demand. A walk round the Sitagarha Farm is worth a dozen pamphlets and 50 meetings of learned research societies. On the 20th I hope to attend the agricultural exhibition at Lari Kalan, a village in this District which has become a model of village reconstruction. These are the things which lead to results.

I have said a good deal to-day about loss of soil and loss of fertility by erosion in our *district*. But the problem is of world wide importance and will soon become, in the opinion of many people competent to speak on it, the most pressing problem in the world. The productivity of the world is declining through man's misuse of the soil. The subject is dealt with in an epoch-making book, called "The Rape of the Earth," of which I have been unable to obtain a copy. I have just read a book, called "Already Walks to morrow," by A. G. Street. Let me quote one or two remarks from that book. About Asia: "The rich farming country of Genghiz Khan is now the Gobi desert." About the United States: "More than half the cultivated lands in the U.S.A. are suffering from erosion." "Man destroyed the prairie and he must find a way to get it back again." In South Africa and Australia he found the same losses by erosion by wind and rain. The conclusion reached by Mr. Street, for the United Kingdom, is nearly the same as that which I have suggested for this Province. He demands a Ministry of Land Utilisation to prevent the misuse of land and to see that land is used in the way for which it is best suited and in the best interests of the community.

To complete this picture of the planning of the country-side, I should have to deal with education—to make the cultivator able to hold his own against the *mahajan* and the lawyer, with the improvement of village life in many ways—better sanitation, better medical relief and better supplies of drinking water, irrigation, improvement of cattle, social reforms and the rehabilitation of the *panchayati* system. All of these are means to one end—the improvement of the health of the village people, the increasing of their happiness and the raising of their standard of living. But life is short and I have concentrated on the need for crying a halt to the destruction of the land we live in.

I have not very much more to say. I have touched only the fringe of this—to me—fascinating subject, and there is room for unlimited study and research and experiment. Interest in these questions in one district is, I am glad to say, growing, and I should like to stimulate that interest and keep it alive by propaganda and example. I should like to see big sums of money placed at the disposal of the Board of Rural Economy, which we have seen in our mind's eye, for a 10-year plan on a big scale. But I know that we have not much hope of that while the war lasts, so that is yet another reason for kicking Hitler as soon as possible off his dictator's perch and giving him his own special private concentration camp.

In conclusion, I must express my acknowledgments to those works from which I have taken many of my facts and figures—"The Forests from Within," by Mr. J. W. Nicholson of the Indian Forest Service, now Conservator of Forests, Orissa: "Indian Forest Wealth," by Mr. E. A. Smythies, I.F.S., and an article on Soil Erosion by Mr. Maclagan Gorrie, I.F.S., in the *Journal of the Royal Society of Arts*—all of which were kindly lent to me by Mr. Sabharwal, who is as keen on the matters which I have talked about as I am and knows much more about them, and I express my thanks to Mr. Markham, the Principal of this College, and to all of you for your kind and patient hearing.

GRAZING CONTROL IN BOMBAY

By E. A. Garland

The Government of Bombay have had under consideration the revision of rules for grazing in the forest districts of this province. A draft of such rules has already been published by the Chief Conservator of Forests in "The Bombay Government Gazette" for the information of the public. The draft rules have received little public support and have been subjected to criticism on various grounds. In view of the large volume of popular opposition to the proposed rules, Government have decided to drop them and to undertake the preparation of a fresh draft more in accord with public sentiment.—(*Extract from "The Times of India," 30th December, 1939*).

As the author of these draft grazing rules, I must admit to a considerable personal interest in the decision of the Bombay Government quoted above. Soil erosion and the associated dangers from excessive grazing and deforestation are, however, now much more widely understood by the general public throughout India than was formerly the case and, consequently, also are of greater political interest. Any decisions in one province, which bear upon these subjects, therefore, are liable to produce repercussions in other provinces and it is from this point of view that some analysis of the draft rules and of possible alternatives may be of interest and even of value.

The draft rules were reproduced in the July, 1939 issue of the *Indian Forester* (Vol. LXV, No. 7, pages 445—452). Rule I consisted of an introductory statement of the objects for which the rules were proposed. The rule was divided into two parts, the first of which recapitulated the well-known fact that uncontrolled grazing by excessive numbers of cattle must inevitably result in deterioration of the pasturage: that is to say, in progressive diminution in the available supplies of fodder both as regards quantity and quality. This part of the rule also pointed out the inescapable sequence of deterioration, whereby disappearance of the soil itself would follow the loss of herbage, until finally only desert would remain. Except that possibly the language used

erred in being too mild as an adequate description of the danger impending, there appears to be little in the first part of this rule to which objection can fairly be raised.

The second part of Rule I pointed out that sound management of grazing grounds involves action in more than one direction. Constructive anti-erosion work must play its part as may be necessary and also the requisite limitations of numbers of cattle admitted to graze are inter-connected with other restrictions, regarding the periods throughout the year during which grazing can be permitted, so that benefit rather than damage to the herbage will result. Such restrictions as may have to be imposed on periods of grazing do not, however, involve complete exclusion. They aim merely at concentrating grazing on some parts of the total available area, so that the remainder may be rested for recuperation. The stricter the control which can be exercised over the animals after admission to the grazing grounds, the less drastic need be the restrictions on the numbers which can be admitted. Such general statements of the broad policies, which must form the basis for sound management of grazing grounds, are aphorisms universally prescribed by all who have studied the problems involved. The rule closed with the following advice to those who might have to put these rules into practice: "Only general principles can be laid down, which should be interpreted and expanded into detail with discretion according to the local circumstances in each case."

So far there appears to be nothing open to serious adverse criticism. Rules II and III provided still further assurances that there should be no harsh or unjust inflictions. Rule II laid down that normally all lands in charge of the Forest Department should be open to free and unrestricted grazing by cattle, so that, under all normal circumstances, the present—completely uncontrolled—freedom to graze private cattle on Government's forest lands would continue uninterruptedly. Only where "Government are satisfied that the pressure of grazing is liable to cause erosion, or loss of soil fertility, or deterioration of the crop of grass and consequently reduction in the quality and quantity of the available grazing" (Rule III) would control have been introduced. It does not seem that there can be any serious reason to believe that "the large volume

of popular opposition" may have been based upon anything provided in the rules up to this point. The assumption may, therefore, perhaps be fairly made that the objections were mainly against the remainder of Rule III, or against parts of Rule VI. (Objections may have been raised to Rules IV and V, which made provision of grazing for sheep subsidiary to the requirements of cattle and which prohibited grazing by goats. It will be more convenient, however, to consider these two rules separately later.)

Rule III laid down the principles upon which the limitations of numbers should be enforced, wherever Government might decide that limitation was in fact necessary. Limitation must obviously and inherently be a thorny problem; and no special virtue is claimed for the particular solution proposed. It was suggested simply because it seemed logical. It did, however, seem to have one special advantage in being flexible and capable of the lightest possible application in its initial stages, so that the uncomfortable, necessary, pressure could be applied gently, but steadily, according to any particular time schedule which might be deemed most appropriate to the special conditions of each locality concerned.

Rule III provided preferential treatment for all cattle essential for economic agriculture. Obviously the basis for accurate definition of the numbers of cattle genuinely economically necessary for agriculture is a matter upon which widely different opinions may be held. Probably most of the owners of cattle would believe, or would like others to believe, that the number of cattle they actually maintained was an economic necessity. Any authoritative decision must certainly take into consideration questions of general agricultural policy, such as, for instance, whether the individual farmer should be encouraged to breed his stock, or whether it is more desirable that the breeding of stock should be mainly a separate occupation from tillage. Such matters of agricultural policy are, however, not suitable for consideration here, nor were they deemed to effect, fundamentally, the scope of these grazing rules: or rather it would be more accurate to say that recognition of these complications resulted in the rules being drawn up in a way which would, it was hoped, allow full latitude for the introduction of any approved policy within this framework. Rule III

merely laid down that the basis for calculation of the number of agriculturally essential cattle in any particular village should be the acreage of cultivated land in that village. There was nothing in the rules which would prevent an assessment of the cattle, deemed necessary for economic agriculture, on a scale which would cover the existing average local practice. If expert agricultural advice indicated that this average was unduly inflated by excessive numbers, maintained for uneconomic reasons, due notice could have been given that a steady, periodic, reduction would subsequently be made in the basic scheduled number allowed per acre as essential. Thus pressure could have been gently exerted, without undue hardship, to rectify gradually the agricultural economy by reducing surplus animals which had previously been unjustifiably maintained. Moreover the basis of calculation for the flat rate of numbers of essential cattle per acre was to be the village, thereby allowing latitude for private adjustments between individual cultivators who might desire to maintain more, or fewer, than the average quota. Thus if X and Y were allotted, on the basis of their holdings under cultivation, permits for four and six essential cattle, but desired only to maintain three and four, there was nothing to prevent a transfer (perhaps for a cash, or other, consideration) of the three surplus permits to Z, who had only been allotted five permits but wanted to keep eight animals.

It seemed logical to correlate the numbers of cattle, for which grazing facilities should primarily be arranged, with the acreage under cultivation. Flexibility was considered equally necessary so that individual adjustments would be possible within the rules and so that—a still more important point—the rules could themselves be adjusted so as to fit localities, in which, on account of natural conditions of soil and climate, tillage should be subsidiary to stock breeding. In the latter circumstances, only the more adjacent grazing areas would have been allotted to "village" cattle, that is to say, for cattle belonging to cultivators, and the remainder would have been kept available for the herds belonging to stock breeders, who, by long tradition find no hardship in camp life, remote from permanent habitations, and whose animals are not required to go daily to work in the fields, nor to be brought nightly to the byres. Much has been heard of the need for "planned" use of the country-side, so that all parts of it can be put to the uses to

which they are inherently, climatically and topographically, most suited. The object of all such planning is the co-ordinated development of all potential resources. These rules planned to regulate the cattle populations so that their incidence could be co-ordinated with other aspects of rural development. The intention was that all decisions, regarding how the available grazing resources could best be allocated, would be made by the Collector of the District, in his capacity as co-ordinating link between all the local public bodies and private interests. Was it to this that popoular opinion objected? Such decisions might equally well have been entrusted to any other appropriate authority, if any such existed with the essential local knowledge, combined with broad unbiased vision.

There is, of course, another aspect of this knotty problem of limitations. Just as a famous English cookery book reminded its readers that, before one can cook a hare, one must catch it, so questions of preferential admission to grazing grounds are dependent upon, and must be co-ordinated with, the amount of grazing available. This aspect of the problem involves many subsidiary conundrums, only one of which can be answered with any certainty: namely that, as has already been said, the greater the control which can be exercised over the cattle after admission to the grazing grounds, the larger will be the number of cattle which can be admitted. If, for example, 500 acres of grazing grounds were available in a particular locality, the admission of even 100 animals might be too much if they were to be allowed to wander as they liked and if nothing was done to improve the area. On the other hand, if the land was properly managed and if the animals were properly controlled, it might be possible, within quite a short time, to have ample grazing for, perhaps, 250 cattle. But the crux of the problem is that only experience—and local experience at that—can enable any one to say with any accuracy what the correct numbers should be at any particular time. Still more difficult is the correlated problem of how the herd should be moved about over the area during the grazing season. What may be a perfect arrangement this year may be a disastrous failure in the following year, simply because the rainfall and consequently the crop of grass is never identical from year to year. Rule VI laid down that

"primary responsibility for all actual management of the land, including assessment of the carrying capacity," should rest with the Forest Department: in fact that the local divisional forest officer, subject to such provisions as might be laid down in the working plan approved by Government, would be responsible. Doubtless the majority of forest officers would gladly be relieved of such a serious responsibility, not so much because of unwillingness to shoulder responsibilities which are part of their duties, as on account of the complete absence of any authoritative basis for the decisions they would thus be forced to make. It may be little exaggeration to say that there is hardly a single person in the whole of India, who, even for the most limited local conditions, can prescribe the correct incidence of grazing, or the correct treatment regarding closures, so that the most beneficial results for any particular pasture may be obtained. To undertake such responsibilities is an inevitable corollary of proper management and so long as the Forest Department is charged by Government with the duty of managing these lands, it is difficult to see to whom else these decisions could be delegated than to the local divisional officer. Is it unreasonable to urge, however, that, when duties are imposed, facilities for the proper discharge of such duties should also be provided? Until extensive research has been organised, no sound basis for such decisions can exist.

Mention has been made of the fact that Rule IV provided that sheep should only be admitted to specially selected areas and that Rule V prohibited goats entirely. The goat is undoubtedly a useful animal but his place, so far as grazing is concerned, is along the hedgerows and grass-verges of the roads, or on other restricted areas not suited for organised grazing by cattle. Similarly, sheep must generally yield place to the more important cattle, upon whose welfare the agriculture of India is dependent to a very considerable extent. Moreover, sheep are alleged to taint the ground and render the grazing unpalatable for cattle. Grazing either by sheep or goats cannot be considered compatible with the development of young trees and as these rules referred to lands entrusted to the Forest Department, tree growing had, at least, to receive subsidiary consideration.

Finally, I may be allowed to refer once again to the object with which this analysis of these rules has been undertaken. I believe that the proper organisation of grazing, not only on lands in charge of the Forest Department, but also on all uncultivated areas, is an urgent necessity all over India. I have no doubt that better rules can be devised, but rules of some sort there must be

in the near future if disastrous waste, or even ruination, of a very considerable Indian asset is to be checked. The greater the delay, the greater will be the loss to be made good and discussion may at least help to clarify ideas and expedite a satisfactory solution. It may be apposite here to quote Sir Frederick Keeble who finished three lectures at the London Royal Institution, on "The Soil and the Green Plant," by saying:

> "Looking back along this long, tortuous road, I find it difficult to believe that anybody could have been so slow to reach the conclusion to which it leads, or could require so much material on which to base a hypothesis which ought to have jumped to the mind long ago. The hypothesis is that *the health and strength of people* and their evolution, and the permanence of human societies, depend on the soil and the green plant. The conclusions are that if the world has got on so well as it has with a half-starved vegetation and a hungry soil, how much better might it not get on when these deficiencies are discovered and made good."

STRENGTH TESTS OF *GREWIA ELASTICA* ROYLE

SYNONYMOUS *GREWIA VESTITA* WALL.

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Five logs under the name of *Grewia vestita* (*siyal phusra*) were received for testing under Project I, from the Sukna Range of Kurseong Division, Bengal. The correct name of the species, as identified by the Forest Botanist, is *Grewia elastica* Royle, with which *Grewia vestita* Wall. is synonymous. The species is, therefore, shown as *Grewia elastica* instead of *Grewia vestita*. Testing of this species has now been finished. The results of tests are shown in the following two tables:

TABLE NO. 1

PHYSICAL AND MECHANICAL PROPERTIES OF *Grewia elastica* (*siyalphusra*)

Species	Moisture per cent	Specific gravity (oven-dry weight and volume at test)	Weight at 12 per cent moisture content, lbs. per cubic foot.	*Shrinkage per cent green to oven-dry*		*Static bending*		*Impact bending*	*Compression parallel to grain*	*Compression perpendicular to grain*	*Side hardness*	*Shear*
				Radial	Tangential	Modulus of rupture, lbs. per square inch	Modulus of elasticity, 1,000 lbs. per square inch	Maximum height of drop in inches	Maximum crushing strength, lbs per square inch	Crushing strength at elastic limit, lbs. per square inch	Average of radial and tangential in lbs.	Average of radial and tangential lbs. per square inch.
Tectona grandis (teak), Burma and Malabar	12	·611	43	2·3	4·2	15,135	1,877	25	8,810	1,510	1,155	1,310
Grewia elastica (*Siyal phursa*), Kurseong (Bengal) ..	12	·677	47	5·4	9·5	15,960	2,173	64	7,970	1,620	1,805	2,080
Fraxinus americana (white ash), U. S. A. ..	12	·60	42	4·9	7·9	15,400	1,770	43	7,410	1,410	1,320	1,950

TABLE No. 2

COMPARATIVE SUITABILITY

Species	Weight in terms of teak	Strength as a beam	Stiffness as a beam	Suitability as a post or strut	Shock-resisting ability	Retention of shape	Shear	Hardness
Tectona grandis (teak) ..	100	100	100	00	100	100	100	100
Grewia elastica (*siyal phusra*) .	110	100	105	9	165	55	155	130
Fraxinus americana (white ash) ..	00	85	90	8	155	60	.30	100

Table No. 1 gives the strength and the physical characteristics of the species in the air-dry condition at 12 per cent. moisture content. The strength of seasoned American white ash is also given for comparison. It will be seen that in all strength properties, *Grewia elastica* is considerably stronger than ash. Table No. 2 is specially prepared to show at a glance the utility of the species for different purposes. The figures are computed by taking into consideration all the strength functions bearing upon any one of the different uses and are shown as percentage of teak which is taken as the standard basis for comparison. *Grewia elastica* is only 10 per cent. heavier than ash and roughly about 10 to 15 per cent. stronger. The figures for strength as a beam, shock-resisting ability and hardness show at once that the wood is especially suitable for hammer and tool-handles and other uses requiring great toughness.

The logs received were small in size and irregular in shape. They could, therefore, provide only a comparatively small number of test specimens. As the species was found to be very tough while testing was in progress, it was decided to test it for hammer-handles. Only a few handles could be obtained. These tests, however, gave very satisfactory results.

Grewia elastica is a very strong, very hard and extremely tough timber. In its strength qualities it is superior to ash and only slightly below hickory. It is easy to work both by hand and machine tools, turns very well and takes a good finish. Athough somewhat refractory to kiln-seasoning, it can be seasoned with little degrade. It air-seasons well if proper care is taken.

Grewia elastica is suitable for making hammer-handles, handles for picks, *phowrahs* and shovels and tool-handles of all sorts. It is also suitable for picker arms and other parts of textile machinery, spokes of wheels, poles, agricultural implements, police battens and generally for articles requiring great toughness with comparative lightness. For the manufacture of built-up tennis-racket frames, plies of *Grewia elastica* can be used to give adequate strength. This species as well as other *Grewia* spp. are useful substitutes for making a variety of articles that are now made from ash, beech, maple and also hickory.

It may be useful to investigate the probable out-turn of this species and the sizes available. Although the consignment tested was obtained from Bengal, Pearson and Brown, in "Commercial timbers of India," say that it is found in Sub-Himalayan forests from Indus eastwards to Bengal. It is also said to be common in the United Provinces. There may be a great demand for handles of all sorts due to war requirements and, if supplies are available, the species can be exploited profitably.

A BATTLE ROYAL

By E. A. Smythies

While Hitler and Stalin were carrying out a cruel and ruthless attack on Poland, two other tigers carried out an equally cruel and ruthless attack in another part of the world. The account below of a jungle battle to the death was given to me by entirely reliable eye and ear witnesses, and, in its main details, is very well authenticated.

The Sarda River, one of the major rivers of the Himalayas, where it debouches from the hills, spreads out into a mile wide bed of boulders and sand, dotted with islands of *shisham* trees and coarse grasses. On the right high bank, sixty or seventy feet above the river, is the small townlet of Tanakpur, with a railway terminus, a bazaar and several bungalows situated on the bluff, looking across the wide river-bed to the wild forest-clad foothills of Nepal. In the cold weather Tanakpur is alive and populated with hill people, forest contractors are busy exporting timber from the extensive forests, and there is a stream of cross traffic to and from Nepal. In the rains it is almost deserted when malaria drives away the hill people and the flooded river cuts all communication with Nepal.

One late evening in the last week of September three men were fishing with nets in the waters of the Sarda, two or three furlongs from the bungalows on the bluff, when, suddenly, two tigers and a half-grown cub emerged from one of the grassy islands close-by. The men shouted and yelled and the tigers moved off across the dry bare bed of the river towards the forest on the right bank a quarter of a mile away upstream from the bluff. Simultaneously from this forest the men heard the trumpeting of a wild elephant. Shortly afterwards the fishermen, and the few dozen inhabitants of the bazaar heard the nerve-shattering roar of a charging tiger and the fishermen saw a big male tusker elephant come out into the open river-bed, being attacked by the two tigers. For three hours the battle between the elephant and the tigers raged up and down the river-bed below the high bluff in full view—in the moonlight—of the bungalows on the cliff. Would I had been there to see and hear! The bazaar inhabitants were so terrified at the appalling noise and infuriated roars of the tigers so close at hand that they barricaded themselves into their houses and no one, except the petrified fishermen who were cut off, saw this awe-inspiring and unique spectacle. About 11 p.m. the noise died down, and next morning the tigers had departed, but the dead elephant was lying at the foot of the bluff, within a stone's throw of a bungalow.

The marks on the unfortunate elephant were very instructive. The trunk was quite untouched and so was the face except deep scratches around the eyes, and *both eyes had been clawed out*. There were terrible bites and scratches on the top of the head and neck, back and rump, and finally the throat had been bitten and torn open—evidently the *coup de grace*.

These are the facts as told to me by the eye-witnesses and by the Tahsil Officer who heard the battle and who had the job of getting rid of the body of the elephant. From them we can deduce the probable—or at least possible—course of events.

It is inconceivable that the tigers made a senseless and unprovoked attack on a full-grown tusker elephant, and equally inconceivable that the elephant started the fight. (He was neither *must* nor a rogue.) It is probable that the tiger cub was the cause of the trouble. He may have blundered into the elephant or gone sniffing around in curiosity and received a kick or a blow for his trouble, causing him to yelp. This would at once raise the maternal fury of the tigress, and the tiger would come to the help of his mate.

The wounds on the elephant give an indication of the tactics of the tigers. It is clear that no frontal attack was attempted, or

the trunk and face of the elephant must have been mauled. Probably one tiger threatened or demonstrated in front, enabling the other tiger to leap on the back (an easy leap for a tiger) and start biting and scratching. It was probably shaken off several times, but again returned to the attack. At some stage of the fight, one of the tigers must have managed to jump or crawl on to the top of the head and from that position to have clawed out the eyes, perhaps deliberately, for it seems a natural instinct of the cat tribe to go for the eyes. One can imagine the poor, blinded elephant, tortured with the fiendish laceration of its back, stumbling along in agony over the boulders and rough ground, falling ultimately over some low bank and exposing its throat to a hellish mauling from the other tiger and dying from loss of blood or the severance of its windpipe. Truly the tigers took a terrible revenge for any possible injury to their cub.

No measurements of the elephant were taken. The tusks were small but old and worn, about 32 inches long excluding a foot or more embedded and 14 inches girth at the base, and the two tusks together weighed 122 lbs.

Although I have heard of elephant calves being occasionally killed by tiger, I have never before heard or read of a fight to a finish between tigers and a full-grown bull-elephant. That it should have taken place before eye-witnesses and within earshot of many more is a piece of remarkable luck.

THE ROLE OF CHEMISTRY IN FORESTRY

PART II

By Dr. S. Krishna

Presidential Address at the Twenty-seventh Indian Science Congress

The question of the conservation of forests does not end when a forest of a right kind, on proper soil, has been raised, the problems of overcutting, fire protection, erosion, etc. properly controlled and other silvicultural operations correctly planned. There are other questions also which have to be looked into. The question of insect pests is an important one, and, if neglected, the forest may be destroyed by insects as rapidly as by any one, or even by the combination of agencies such as overcutting, fire, grazing etc.

Forests harbour innumerable species of insects and other lower forms of life, all of which are not helpful for proper conservation of trees. Most of these live on dead or fallen trees but

many more find their nourishment in living trees. It is the latter varieties, be they virus, bacteria, fungus or insects that cause untold damage to forests. And, therefore, every measure has to be adopted to eradicate or at least minimise the destruction caused by these agencies. It has been estimated in the United States of America that injurious insects cause a damage worth nearly two billion dollars; bacteria and fungus add another billion. In India, a single epidemic of sal (*Shorea robusta*) borer has been known to cause damage estimated at several lakhs of rupees[10] and to check the inroads of such pests many measures (silvicultural, prophylactic, biological control and chemical control) are adopted. It is for chemical control that the services of chemistry are needed. Chemists have placed in the hands of entomologists several chemical compounds, both natural and synthetic, that attract, repel or kill insects. The use of citronella oil as a repellant for mosquitoes is known to everyone, as also eugenol as attractant for the Japanese beetle, and terpenyl acetate and methyl cinnamate as attractants for oriental fruit moth. Turpentine, rosin, pine-tar, nicotine preparations, lead, arsenic, copper and mercury compounds have also been in use for a long time in combating insect attack and diseases. Recently a newer type of insecticides of plant origin, such as derris and pyrethrum have come into prominence, but their applicability to forestry work, outside the nursery or very young plantations, is as yet very limited, mainly on grounds of economy. All these have great economic possibilities.

The part which chemistry plays in the utilisation of forest produce is far more varied and extended than it is in silviculture and conservation. Wood is the most important forest produce. Its utilisation dates back to the earliest period of human history and its principal use, *i.e.*, as firewood and as structural and furnishing material, still continues to be the same, with the difference that the present-day man, with his scientific knowledge of the structure, constituents and physical properties of wood, knows its limitations and possibilities. The chief limitation of timber is its liability to decay and scientific research has, therefore, been specially directed to remove this defect.

The principal characteristic of wood is that it possesses "lignified" vascular tissues With increasing age the inner tissues of trees are transformed into what is called "heartwood," wherein infiltration of certain organic and mineral constituents into cell walls takes place. The infiltration of such constituents, however, does not add much to the strength or weight of the heartwood but imparts to it certain properties which are lacking in the outer layer called the "sapwood." Sapwood is usually rich in

fermentable and mineral compounds and, hence, is more liable to attack by insects and fungi.

Water[11] plays the fundamental rôle in the behaviour of timber. In the living tree the amount of moisture held by capillary forces may range from 25 to 30 per cent. of its dry weight, varying in different species and seasons. Besides this free water occupying the cavities of cells, vessels and pores, there is also hygroscopic moisture held by sorption between fibrils, which form the cell walls; its maximum (about 30 per cent.) is designated as the "fibre-saturation point." After the tree has been felled it begins to lose part of its moisture, until it reaches an "air-dry" condition, corresponding to the relative humidity of the atmos phere. In the drying of wood, free water is expelled first, without apparent effect on its physical properties. It is the extraction of the intermicellar moisture (below the fibre-saturation point) that causes the volumetric contraction of wood (shrinkage), just as the reverse operation, *i.e.*, re-absorption of moisture up to the fibre saturation stage, results in the expansion of tissues or swelling.

When timber is allowed to dry in the shade under proper conditions, it loses its moisture slowly and hence develops least amount of stresses between the layers of wood, on account of the shrinkage of cells, and, consequently, suffers least amount of degradation in the form of cracking, checking or warping. Such wood, dried through and through and containing about 8—15 per cent. of moisture (on dry-wood material), is said to be seasoned. A seasoned wood is in a state of equilibrium with the atmpospheric humidity and suffers very little of further degradation when used for structural or furnishing purposes. What chemical changes in the constituents of wood result from this slow process of seasoning have not been fully studied but it has been established that starch depletion is one of them, seasoned wood being less liable to the attack of fungi and insects than unseasoned wood. But the demand of modern civilisation for seasoned timber has necessitated the cutting short of this slow process of air seasoning and has replaced it by kiln-drying to a large extent. The operation is based on transfusion of moisture from inside to outside and evaporation of moisture at a much quicker rate without causing any degradation of the timber. For all practical purposes kiln-dried wood is as good as air-seasoned wood and in certain respects it is even better. It is true that in rapid kiln-drying changes like starch depletion do not occur. All the same, the attacks of insects are as few as in air-seasoned wood on account of the greater degree of dryness which can be attained in kiln-seasoning.[12] Furthermore, at the high temperature of the kiln, most of the fungi and insects

originally present in the wood are killed. This, therefore, is a distinct advantage over air-seasoning. Soaking of converted timber in solutions of certain salts (sodium chloride, calcium chloride, zinc acetate, ammonium phosphate, etc.) has also been found helpful in moisture movement and more rapid drying in kiln-seasoning.[13] The possibility of reducing the time for seasoning still further is envisaged by experiments conducted in Russia, which indicate that timber can be seasoned more quickly by exposure to ultra-short waves.[14]

Although seasoning imparts to timber considerable immunity to fungus and insect attack, it cannot protect it under all conditions of use, particularly when wood is exposed to rain and water. Certain timbers possess a fair degree of natural immunity against decay caused by these agencies, while others are more vulnerable. Sapwood, even of the most resistant wood, is very much less resistant to the attack of insects and fungi than the heartwood. This natural immunity which the heartwood of some of the timbers possesses is ascribed to their containing certain constituents, which are either distasteful or injurious to insects and fungi. Chir (*Pinus longifolia*) wood, for instance, is readily attacked by a variety of insects, but its highly resinous stumpwood (chilka) is perfectly immune to such attacks. Similarly, teak possesses immunity by virtue of its containing an oleoresin. But there are only a few hard-woods available in India which are so resistant to decay; consequently, it is only these which are sought and extensively used. On the other hand, there are innumerable softer woods which, although quite useful for a variety of purposes, are not being used on account of their liability to decay. The problem of wood preservation is, therefore, of great economic importance, not only because it reduces the appalling loss of timber due to destruction by insects and other lower forms of life but it also makes it possible to use those timbers which, hitherto, have been considered inferior.

The lines on which this problem has been attacked follow more or less the natural process, *i.e.*, the introduction into timber of chemicals that are poisonous to insects. Copper, mercury, chromium, zinc and arsenic salts and a few organic compounds, singly or in combination, have all been employed with varying

degree of success. The problem of impregnation of preservatives into timber, even with pressure, is not so simple as it would appear to be. It has already been stated that fluids pass through sapwood more freely than in heartwood and normally it would be expected that penetration in softer wood should be better than in hard-wood. But it has been observed that in the case of chir, a soft-wood, penetration is very erratic. The cause of such behaviour is being enquired into but no explanation has yet been put forward. As the result of such imperfect penetration of preservatives, cracks developing in treated timber expose untreated surface to the attack of insects and fungi and decay follows in spite of the preservative treatment. This difficulty appears even in the case of oil-soluble preservatives which, but for their high cost, appear to be more satisfactory. Chances of leaching of the preservative are less in the case of such preservatives and, the moisture content of the timber not being disturbed, chances of subsequent cracking are also minimum. The difficulties attending the use of water-soluble salts as preservatives are still greater. The difficulty with regard to penetration is equally great in this case as in the other, and, in addition, by increasing the moisture content of wood, such preservatives make the timber more liable to crack during subsequent drying, unless kiln-seasoning is again resorted to, which would make the process more expensive. Moreover, unless steps are taken to fix the preservative in the wood, chances of leaching, with loss of preservative action, are much greater. Arsenic and copper in the presence of dichromate appear to be fixed in the wood, but the mechanism of the reaction is not fully understood. Thus, taking into consideration both the economic aspect and the method of approach, the problem of wood preservation does not appear to have been solved satisfactorily as yet. One possible line of attack to this problem, which is being investigated in America, appears to lie in inducing resins to be formed inside the wood by the injection of suitable constituents from outside.[15] This will act both as a preservative and as a check to fibre-swelling and degradation of wood by warping, etc., on account of the absorption of moisture.

The discovery of the excellent cementing properties of casein has resulted in the manufacture of laminated wood which has opened

up a new field for the utilisation of timber. Timbers, which at one time were considered to be of little value, are now being extensivly used to form the inner core of laminated planks. By adding facings of costly decorative wood and thereby using only a very small quantity of the latter, beautiful laminated planks of very attractive designs are now being manufactured for furnishing purposes. In this matter of utilisation the chemist, again, has been of service to forestry.

Besides the principal uses referred to above, some woods are utilised for the production of useful products, many of which are of fairly remote antiquity. For instance, the extraction of *cutch* and *katha* (crude catechin) from *Acacia catechu* (*khair*) wood, distillation of sandalwood oil or of camphor from camphor wood have long been practised in this country. Modern chemistry has, however, opened newer fields for the utilisation of wood. Amongst these, mention may be made of the manufacture of paper pulp and the saccharification of wood.

Apart from timber, which is the major produce, forests yield a large number of other materials, commonly designated as Minor Forest Products. These include flowers, fruits, leaves, barks, roots, herbs, bamboos, grasses, flosses, fibres, gums, resins and a host of other products of vegetable and animal origin. These yield a large proportion of the forest revenue. With the demand for rapid industrial development of the country, these products of Indian forests deserve greater attention since they form the raw material for many of the existing or the future industries. In any plan of national industrial development, these are bound to play a more important part than heretofore. At the present moment, the value of this natural wealth is not fully realised; but with greater care on the part of foresters (as producers) and greater interest on the part of industrialists (as consumers) there is no reason why these products should not attain an importance of the first rank in the national economy.

The total land area of British India (Burma, Federated Shan States and Andamans not included) is nearly 846,000 square miles, of which 98,000 square miles is managed by the Government Forest Department. The forests under Government management are

neither well-distributed in all parts of the country, nor are they all of equal value. Coorg, for intsance, possesses 53 per cent. of forests, followed by Assam with 38 per cent., while Bihar, N.W.F. Province, Baluchistan and Sind all have under 3 per cent.

The revenue to the Government from royalty on M. F. P. (Minor Forest Products) in 1937-38 was nearly 119 lakhs, of which fodder grasses contribute Rs. 70.68 lakhs, bamboos Rs. 13.84 lakhs and other M.F.P. Rs. 34.19 lakhs. The royalty of Rs. 48 lakhs (grasses excluded) may appear, at first sight, a comparatively small sum but it assumes a respectable magnitude of nearly three crores when it is pointed out that the market value of a produce is five to six times the royalty it yields. Speaking generally, the attention of the Forest Department is concentrated on production and conservation of timber-yielding trees and most of the money and energy are consequently devoted towards that end. M.F.P. are relegated to a very minor position and while they add considerably to forest revenue, very little is done towards their conservation and improvement. They remain neglected even though, on their own merit, they deserve greater care and attention. The demand for M.F.P. is daily increasing. It is slow but steady and this is noticeable from the fact that, while they yielded in 1910-11 an income from royalties amounting to Rs. 34 lakhs, the income from the same source in 1937-38 was over 48 lakhs, not including the value (eight lakhs) of those products which were given away free or at reduced rates. Rs. 48 lakhs is, however, not the maximum revenue that M.F.P. are capable of yielding and this could easily be increased substantially if only the forest officers were alive to the full commercial value of these products. For example, artemisia and ephedra, which replace grass in the regions where they grow in India were, at one time, being used only as cheap fodder and fuel. But their importance as valuable drugs having been shown, they are to-day worth several lakhs of rupees.

The value of M.F.P. in a province which has a considerable area under forest may not appear big in comparison to the revenue derived from timber but in those provinces (Baluchistan, N.W.F.P., etc.) where the forests are scanty (about 3 per cent.), M.F.P. assume quite an important position. For example, Baluchistan forests

which were being run at a deficit for over 30 years have only recently, on account of the sale of ephedra, become solvent, making a surplus of Rs. 20,000. Apart from the revenue to the Government, the benefit accruing to the villagers living in or near forest is very considerable. For the collection and transport of Rs. 48 lakhs worth of M.F.P. it may be safe to assume that their wages amount to nearly a crore-and-a-half of rupees. This money the villagers earn for part or spare-time work which in many instances mean a substantial increase in their family income.

Objections are frequently raised that the collection of Minor Forest Products is expensive and undependable and that there is not enough of any particular material concentrated in any one locality to meet the requirements of a factory at economic cost. This, perhaps, is true for many of the products, but it may be stated with confidence (although proper surveys of the quantities available for most of the M.F.P. are still wanting) that there is ample material which can be worked up on a "cottage-industry" scale. This aspect has a special significance and appeal in a country like India. For instance, take the case of *katha* manufacture in the United Provinces. Large quantities of the raw material (*Acacia catechu* heartwood) are available and yet their transport to the factory at Bareilly adds so much to the cost that it is far more economical to produce crude *katha* on a small scale in different parts of the forest. In fact, if the villagers could be taught to use improved methods of extraction and concentration of the catechu extract, they would be able to produce a product with which the factory-made *katha* would find it difficult to compete.

(*To be continued.*)

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BEIN RIVER PROTECTION WORKS, SHAKARGARH TAHSIL

MATTRESS-FACING OF BANKS UNDER EROSION

BY G. W. D. BREADON,
District Engineer, Gurdaspur District

Plate 12, Fig 1, is a photograph of the shrub *Ipomæa carnea*, which is very extensively employed in the Gurdaspur District on engineering works for protective purposes and also as a fence in arboricultural planting. It is perennial, evergreen, easily grown from cuttings, immune to insect and disease attacks, is not eaten by goats, cattle and camels and grows luxuriantly on both dry and wet soils. It attains a height of from 10 to 12 feet and propagates by throwing out root-suckers, thus forming thick clumps of moderately thin and long stems which bend to the action of water, preventing any damage to the bank on which it is growing. For this reason it is pre-eminently suited for the protection of banks of rivers and canals.

For protecting river-banks the stems of the shrub are fashioned into long fascines, as shown in Plate 12, Fig. 2. Each cylindrical faggot is formed round a strong rope, one end of which terminates in the anchor of bricks or stone filled in a gunny-bag, while the other end is left long enough for securing the fascine to the bank. The fascine is bound at two-foot intervals, along its entire length, with thin rope or withes.

When making the fascine, care should be taken to place the thick ends of the stems pointing downwards towards the anchor, so that the cuttings will grow naturally when they take root.

The anchor is buried in a deep trench cut along the toe of the bank.

Plate 12, Fig. 3, presents a view of a part of the mattress composed of a series of fascines laid side by side along the river-bank, which is under erosion. The river had risen six feet after the mattress had been made, for which reason the lower part is not visible.

Besides being secured by anchors and to pegs on the top of the bank, the fascines are further held in position by ropes stretched horizontally across the mattress, bound round the fascines and pegged at intervals. This prevents heaving, as well as lateral displacement.

Fig. 1

Fig. 2

Fig. 3

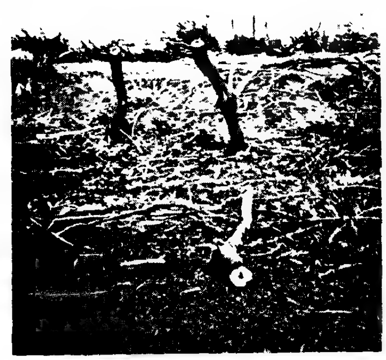


Fig. 4

Fig. 1

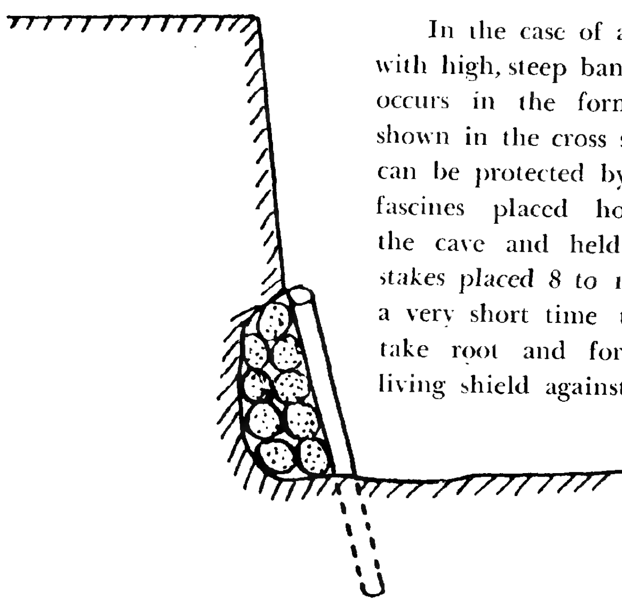
Fig. 2

Fig. 3

Observe the manner in which the mattress is secured to the bund on the river-bank. The work had just been started when the photograph in Fig 4, Plate 12, was taken, for which reason the full number of anchor-pegs is not shown. Ordinarily four fascines are tied to one peg.

Plate 13, Fig. 1, shows the downstream end of a mattress now very much a living thing—that was made last year, when the river had eaten away its bank to within a few yards of the village of Chakrah. The river-crossing—that is the direction of flow of the main stream from one bank to the other—had made a dead set on Chakrah, and, when work was taken in hand, only 3 feet of the bund, along the bite of 300 feet, stood between the river and the village. The mat was laid in two days. It stood up against the floods of the whole of last monsoon, and it is now stronger and more fitted in its living state to meet any aggression.

In the foreground is to be seen a quantity of material that had been thrown in by *baildars* to close a cattle ramp foolishly made by villagers.



In the case of a river or gully with high, steep banks, where erosion occurs in the form of caving, as shown in the cross section, the bank can be protected by *Ipomœa carnea* fascines placed horizontally along the cave and held in position by stakes placed 8 to 10 feet apart. In a very short time the cuttings will take root and form a permanent living shield against further erosion.

Plate 13, Figs. 2 and 3, are of three-year-old roadside plants, reared inside ring-fences of *Ipœmia carnea.* This is the form of

fence generally used in this district with very good results. As long as the shrub is trimmed and not allowed to smother the plant, no harm results. To say that the sheltered plant is deprived of water is a fallacy, because the tap-root of the shrub penetrates to a considerable depth into the soil and its fibrillæ are at the terminals of the branching root system.

As a fence there is nothing cheaper than this most useful shrub. No capital expenditure has to be incurred and no money has to be spent on repairs. It protects the plant from all forms of disease and from spoilation by insects and animals. It guards its protege against frost in winter and heat in summer and, in its surrounding embrace, the plant grows tall and straight, without low lateral branches, which reduce the value of timber. When properly trimmed by the mashki, the live fence adorns the roadside, while most other forms of plant-guards are unbecoming. In addition to all its other merits, the height of the living fence can be increased as the plant within the ring grows taller.

Ipomœa will prevent "wash-outs" on roads subject to inundation, as on the Dina Nagar—Narote Jamil Singh Road in the bed of the Parmanand River. It will serve instead of stone or brick pitching on approaches to bridges. It will guard river-embankments, make reclaimed lands on river sides permanent and as a protection against erosion there is perhaps nothing that will do its work more faithfully than *Ipomœa carnea.*

TIMBER PRICE LIST, FEBRUARY—MARCH 1940

(ISSUED MONTHLY BY THE FOREST RESEARCH INSTITUTE).

Trade or Common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Baing	*Tetrameles nudiflora*	Assam	Logs	Rs. 35-0-0 per ton in Calcutta.
Benteak	*Lagerstrœmia lanceolata*	Bombay	Squares	Rs. 32-0-0 to 70-0-0 per ton.
"	"	Madras	Logs	Rs. 40-10-0 per ton.
Bijasal	*Pterocarpus marsupium*	Bombay	Logs	Rs. 69-0-0 to 90-0-0 per ton.
"	"	Madras	Logs	Rs. 37-8-0 per ton.
"	"	Bihar	Logs	Re. 0-8-0 to 0-14-0 per c.ft.
"	"	Orissa	Logs	Re. 0-10-0 to 1-8-0 per c.ft.
Blue pine	*Pinus excelsa*	N. W. F. P.	12′×10″×5″	Rs. 6-0-0 per piece.
"	"	Punjab	12′×10″×5″	Rs. 4-12-0 per piece.
Chir	*Pinus longifolia*	N. W. F. P.	9′×10″×5″	Rs. 2-4-0 per piece.
"	"	Punjab	9′×10″×5″	Rs. 2-14-0 per piece.
"	"	U. P.	9′×10″×5″	Rs. 3-2-0 to 3-4-0 per sleeper.
Civit	*Swintonia floribunda*	Bengal	Logs	Rs. 25-0-0 per ton.
Deodar	*Cedrus deodara*	Jhelum	Logs	
"	"	Punjab	9′×10″×5″	Rs. 4-8-0 per piece.
Dhupa	*Vateria indica*	Madras	Logs	
Fir	*Abies & Picea* spp.	Punjab	10′×10″×5″	Rs. 2-10-0 per piece.
Gamari	*Gmelina arborea*	Orissa	Logs	
Gurjan	*Dipterocarpus* spp.	Andamans	Squares	
"	"	Assam	Squares	Rs. 56-4-0 per ton.
"	"	Bengal	Logs	Rs. 30-0-0 to 35-0-0 per ton.
Haldu	*Adina cordifolia*	Assam	Squares	Rs. 60-0-0 per ton.
"	"	Bombay	Squares	Rs. 24-0-0 to 65-0-0 per ton.
"	"	C. P.	Squares	Re. 0-4-0 to 0-13-0 per c.ft.
"	"	Madras	Logs	Rs. 40-10-0 to 46-14-0 per ton.
"	"	Bihar	Logs	Rs. 0-6-0 to 0-8-0 per c.ft.
"	"	Orissa	Logs	Re. 0-4-0 to 0-10-0 per c.ft.
Hopea	*Hopea parviflora*	Madras	B. G. sleepers	Rs. 6-0-0 each.
Indian Rosewood	*Dalbergia latifolia*	Bombay	Logs	Rs. 62-0-0 to 100-0-0 per ton
"	"	C. P.	Logs	Re. 0-12-0 to 1-2-0 per c.ft.
"	"	Orissa	Logs	
"	"	Madras	Logs	Rs. 137-8-0 per ton.
Irul	*Xylia xylocarpa*	Madras	B. G. sleepers	Rs. 6-0-0 each.
Kindal	*Terminalia paniculata*	Madras	Logs	Rs. 44-12-0 to 47-10-0 per ton.

Trade or Common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Laurel ..	*Terminalia tomentosa* ..	Bombay ..	Logs ..	Rs. 40-0-0 to 65-0-0 per ton.
,, ..	,, ..	C. P. ..	Squares ..	Rs. 0-12-0 per c.ft.
,, ..	,, ..	Bihar ..	Logs ..	Re. 0-6-0 to 0-8-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Re. 0-6-0 to 0-10-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 50-0-0 per ton.
Mesua ..	*Mesua ferrea* ..	Madras ..	B. G. sleepers..	Rs. 6-0-0 each.
Mulberry ..	*Morus alba* ..	Punjab ..	Logs ..	Rs. 1-14-0 to 4-12-2 per c.ft.
Padauk ..	*Pterocarpus dalbergioides*	Andamans ..	Squares ..	
Sal ..	*Shorea robusta* ..	Assam ..	Logs ..	Rs. 31-4-0 to 75-0-0 per ton.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 5-14-0 each.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 2-12-0 to 2-14-0 each.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 20-0-0 to 75-0-0 per ton
,, ..	,, ..	Bihar ..	Logs ..	Rs. 0-7-0 to 1-3-0 per c.ft.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 4-12-0 to 5-6-0 per sleeper.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 2-0-0 to 2-3-0 per sleeper.
,, ..	,, ..	C. P. ..	Logs ..	Rs. 1-2-0 to 1-4-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Re. 0-8-0 to 1-2-0 per c.ft.
,, ..	,, ..	U. P. ..	Logs	Re. 1-2-0 to 1-6-0 per c.ft.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 2-4-0 to 2-8-0 per sleeper.
,, ..	,, ..	,, ..	B. G. sleepers	Rs. 5-10-0 to 5-12-0 per sleeper.
Sandalwood ..	*Santalum album* ..	Madras ..	Billets ..	Rs. 306-0-0 to 639-0-0 per ton.
Sandan ..	*Ougeinia dalbergioides* ..	C. P. ..	Logs ..	Re. 0-10-0 to 1-3-9 per c.ft.
,, ..	,, ..	Bihar ..	Logs ..	Rs. 0-8-0 to 2-0-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Re. 0-12-0 per c.ft.
Semul ..	*Bombax malabaricum* ..	Assam ..	Logs ..	Rs. 37-0-0 per ton in Calcutta.
,, ..	,, ..	Bihar ..	Scantlings ..	Re. 0-4-0 to 0-10-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	
Sissoo ..	*Dalbergia sissoo* ..	Punjab ..	Logs ..	Re. 0-11-8 to 1-12-5 per c.ft.
,, ..	,, ..	U. P. ..	Logs ..	Re. 0-12-0 to 1-8-9 per c.ft.
,, ..	,, ..	Bengal ..	Logs ..	Rs. 35-0-0 to 75-0-0 per ton.
Sundri ..	*Heritiera* spp. ..	Bengal ..	Logs ..	Rs. 20-0-0 to 25-0-0 per ton.
Teak ..	*Tectona grandis* ..	Calcutta ..	Logs 1st class	
,, ..	,, ..	,, ..	Logs 2nd class	
,, ..	,, ..	C. P. ..	Logs ..	Re. 0-12-4 to 2-12-0 per c.ft.
,, ..	,, ..	,, ..	Squares ..	Rs. 0-11-5 to 2-3-10 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 84-6-0 to 135-15-0 per ton.
,, ..	,, ..	Bombay ..	Logs ..	Rs. 66-0-0 to 180-0-0 per ton.
,, ..	,, ..	,, ..	M. G. sleepers	Rs. 3-14-0 each.
White dhup ..	*Canarium euphyllum* ..	Andamans ..	Logs	

EXTRACTS

PROGRESS AT THE FOREST PRODUCTS RESEARCH LABORATORY, PRINCES RISBOROUGH

TIMBER RESEARCH

The steadily increasing interest taken in timber research by industry is clearly indicated in the Annual Report of the Forest Products Research Board for 1938 issued to-day by the Department of Scientific and Industrial Research (published by H. M. Stationery Office at 1/6 net).

The enquiries dealt with by the Forest Products Research Laboratory were more numerous than in any previous year and covered practically every aspect of the subject. About half were concerned with the identification of timber, in some cases information being required in order to obtain supplies of a particular grade of timber and in others to establish the identity of a timber offered under an unfamiliar trade name. Nearly 700 enquiries were related to problems of seasoning and wood bending. These included requests for tests to determine how the hygroscopicity of wood is affected by fire-proofing treatments, and enquiries about the effect of exposure to damp conditions on the subsequent tendency of veneers to lift and blister. The influence of moisture-content changes on block-boarding, the behaviour of wood-block flooring when laid in asphalt, the kiln-drying of maple shoe-last blocks, and the kiln-drying of beech brush-back blanks.

Another large group of enquiries concerned the strength of timber, the properties of plywoods, glues, etc., and problems involved in wood-working and wood cutting. In this last section the subjects dealt with included: The causes and possible remedies for mechanical failure of saws, cutterheads, etc., factors affecting the efficiency and finish in various machining operations, mathematical data relating to the stresses acting in saws, comparative costs of production with use of steam and electrical power, utilisation of wood waste and design of plant for this purpose, modifications to cutting conditions necessary to obtain improved results in the working of a number of timbers, design of tools and machines for special purposes, specifications for saw-teeth, cutting angles and speeds for particular species of timber, power requirements in various operations and a variety of other matters.

Other problems referred to the Laboratory included the decay of timber in buildings as the result of fungus attack and the occurence of mould or stain, wood preservation and fire-proofing treatments and the preservation of timber for national defence purposes. Another group of nearly 700 enquiries concerned insect damage to timber--the chief culprits being the common furniture beetle and the longhorn beetle. In addition, 22 inspections were carried out mainly for architects and church authorities, about half of these being made on account of damage caused by death-watch beetles.

Charcoal Manufacture in Portable Kilns.—A good deal of work was carried out during the year on the production of charcoal in portable steel kilns. The increasing use of charcoal for various industrial purposes, particularly in the manufacture of rayon, has demonstrated—the report states—the extent to which this country is dependent on foreign supplies. Hitherto, too great a percentage of volatile matter in the charcoal has been the chief objection to charcoal made in portable kilns, but an experimental kiln has now been designed and constructed which goes far in removing this objection. Charcoal produced by certain burnings has been pronounced by a leading firm of rayon manufacturers—who have given financial support to the investigation -to be equal to the best obtainable from any source. Close touch has also been maintained

with developments in the use of wood and charcoal as alternative fuels for motor vehicles.

Moisture Content of Wood.—Further investigations were made during the year into methods of treating timber to prevent contraction or swelling due to changes in the amount of moisture in it resulting from variations in atmospheric conditions. New substances, the report states, which appeared to offer possibilities in this direction, have been tested, but, so far, no material has shown such promise as sorbitol—a near relation of the sugar family. Soaking in a solution of sorbitol was found to be an effective method of treatment for oak veneers, and was repeated using green beech and oak boards half inch and one inch thick respectively. The experiments on the sorbitol-treated beech boards have been completed, and it was found that the movement was appreciably reduced, provided that a fairly high concentration (15—20 per cent. by weight) of sorbitol was present. Experiments with oak boards are sufficiently far advanced to demonstrate that the effects are superior to those obtained in beech. The presence of about 20—25 per cent. of sorbitol (by weight) reduces the movement by 40—50 per cent.

Frequent enquiries, the Report continues, are received concerning the rate at which dry timber will absorb moisture if stored in a damp place. The problem is of immediate application in the case of new buildings, and is sometimes not without importance where repairs and alterations are being made in museums and workshops in which valuable decorative woodwork is in storage. Results are given of tests on the absorption rates of oak, mahogany, teak, red deal, white deal and British Columbian pine.

The Report points out that when dry timber is stored for long periods, or alternatively when air-dried timber is to be further seasoned to make it suitable for indoor use, it is very desirable that the storage conditions should correspond, as far as possible, to a moisture content of about 12 per cent. In a high humidity climate like that of this country, the required conditions can generally be attained by slight heating. A simple apparatus has been devised for automatically controlling the air conditions in a store. A block of wood is first conditioned to the desired moisture content and adjusted so that its expansion, as a result of increase of the moisture

in the block, closes a switch which brings the heating apparatus into play. The rise in air temperature lowers the humidity, thus causing the wood-block to dry and shrink and so break the electric contact at the switch.

Box-Testing.—In the box-testing laboratory, tests were made for the Air Raid Precautions Department of the Home Office on two patterns of cartons for respirators.

Cartons have also been tested on behalf of the Ministry of Agriculture and Fisheries for the carriage of National Mark eggs in half-dozen and dozens. The cartons were required to offer maximum protection to the eggs against breakage, give reasonable resistance against pilfering and to fit a standard outer container.

Several series of tests have been carried out for manufacturers, including tests of material such as fibreboard and a special maizeboard, and containers for canned milk, soap, telephone instruments and whisky bottles.

Wear of Floors.—A number of tests have been made on the suitability of various timbers for flooring. In this work an experiment was carried out to determine the effect of repeated applications of oil to wood flooring. The timber used was American oak and comparative tests were made between panels treated once only with oil and panels treated at intervals during the test. The repeated application of oil was found to retard the surface breakdown to some extent, though there was no change in the form of the ultimate failure. On this evidence, regular treatment with oil helps to maintain the surface of floors carrying relatively light traffic, but makes little difference when the traffic is so heavy as to cause more rapid breakdown of the surface.

Other Investigations.—The National Physical Laboratory is carrying out preliminary tests for the Forest Products Research Laboratory on the drying of timber by high frequency electric fields such as those produced by radio transmitters. Experiments have also been carried out to discover whether the presence of wood-destroying insects can be detected by X-rays.

The rapidly increasing number of inquiries received at the Laboratory on "Composite Wood" has led the Forest Products Research Board to consider detailed proposals for the installation of equipment for research.

The field covered by these products includes all the industries interested in "solid" wood and several industries in which the use of wood has practically been abandoned.

PROTECTING AN ASSET

Among the more lasting of the changes effected by the Congress Ministry during their tenure of office was that in the policy of the Forest Department, particularly in its relations with the general public. Legitimate grievances of the people were redressed and concessions allowed to the extent possible without relaxation of the essential principles of conservation. Speeches by Ministers and Parliamentary Secretaries revealed a welcome understanding of the importance of forests to the Presidency, and the limitations imposed upon their exploitation by the above-mentioned principles. In his report on the administration of the Forest Department during the year 1938-39, and also in his summary of the progress of that administration during the five years ending March 31 last, Mr. C. C. Wilson, Chief Conservator of Forests, describes the manner in which public opinion was met:

> "From 1938 the grazing fees were reduced by 50% throughout the Province. Free removal of grass in head-loads was permitted in most of the divisions. The removal of dead wood was permitted on payment of a nominal fee .... the area open to grazing was increased, watering facilities were improved and penning was encouraged. Large areas were allotted for Kumri cultivation .... Raw materials were supplied to cottage industries as far as possible. Officers interviewed the people during their tours, heard their grievances and redressed them as far as possible, and tried to create a 'forest sense' among them."

From this it will be seen that the Congress Ministry's policy differed greatly from that which caused the late Dewan Bahadur P Kesava Pillai to champion so zealously in Council and without, the claims of the people to a larger share of the produce and grazing opportunities afforded by the large forest areas in this Presidency.

But the late Congress Ministry were ready to admit that there is a point beyond which exploitation cannot go. It is emphasised by Mr. Wilson in his report for the year 1938-39: "It is important to realise," he writes, "that forests are indispensable to the well-being of any country, and that over-exploitation will result in their rapid denudation and destruction. The present Government have granted various concessions and facilities to the people who live on the borders of the forests in addition to those already being enjoyed by them: but it must be realised that there is a limit beyond which it is not possible to go, and that it is very far from being to the best interests of the country to be continually pressing for more and greater concessions." Mr. Wilson was obviously addressing the more importunate of the late Government's supporters. Few among them realised the full value of the asset they wished to exploit without thought of its preservation. Mr. Wilson's report should be read by all who demand more concessions and greater facilities for the exploitation by the people of the forests During the five years ending March 31, 1939, the forests contributed Rs. 22,94,931 to the provincial revenues. In the year 1938-39 nearly 3¼ million animals grazed on forest land, and large quantities of fodder, manure, fuel and building materials were provided for the people. This, in addition to the huge revenue from commercial exploitation, which, during the five years above referred to, reached well over rupees two crores.

This being so, it is comforting to learn that "the evil effects of the denudation of the forests and consequent soil erosion, resulting in water scarcity at times and floods at other times, and causing famine and doing considerable damage to property, are being realised to a much greater extent than in the past." Had this awakening come earlier, there is little doubt that large tracts of India, now arid desert, would have been saved. Mr. Wilson refers to the Note prepared by the Committee of the Fourth British Empire Forestry Conference on "Forests in Relation to Climate, Water Conservation and Erosion." That Note is a revelation of the way in which vast areas have been ruined by thoughtless or ignorant destruction of forests. Every country has its examples of such wasteful exploitation, but South India has, for the great part, been spared the worst of such despoliation thanks largely to the policy of past Govern-

ments who have placed forest conservation in the fore-front of their administrative programmes. Yet the need for vigilance continues. The report tells us of areas, notably the Madinikonda Reserved Forest near Madanapalle town, denued by overgrazing and reckless exploitation while under panchayat management. Fortunately, it was transferred back to the Forest Department before irreparable damage was done, and regeneration operations are now being carried on with encouraging results, "the main purpose being to check erosion."

This Presidency cannot guard its forests too carefully. They are essential to the welfare of millions Without the protection they afford, a great part of the province would gradually become desert, while large areas would be subject to all the terrors of alternate floods and drought. Fortunately, the representatives of the people who have, during the past twenty years, been entrusted with the administration of the Province, have appreciated this fact. And if the efforts of the Forest Department to educate the people in the importance of the forests in the rural economy of the Presidency meet with the success they deserve, such deplorable incidents as the denudation of the Madinikonda Reserve will become extremely rare, if they do not disappear altogether. For, though the dweller in rural areas is conservative, he is not slow to appreciate what is good.—*The Madras Mail,* January 19, 1940.

CHOTANAGPUR FORESTS BILL

The Preservation of Forests is a problem of the utmost importance to the economic prosperity of any country. Unfortunately, this fact is not as fully realised as it ought to be in ours and the result is that the denudation of forests has been proceeding at a disastrous pace here. The preservation of the forests in many countries and even in some of the provinces in India is a Government responsibility and the usual method in which this is done is by "reserving" some of the forests and by declaring others as "protected." In Bihar the reserved and protected area under forests is the smallest in comparison with the other provinces. It is only 2.8 per cent. of the total area of the Province as against the 10.4 per

cent. in Central Provinces, 11.5 in Madras, 11.4 in Bombay and 9.3 in Bengal and as against the accepted rule of forest authorities that from 16 to 18 per cent. of the total area of a country should be demarcated as under forests. So far as Bihar is concerned, Chota Nagpur is the one part of it which had once an extensive area under forests but even that division is unfortunately becoming gradually denuded of it, owing to the ravages of the forest contractors, the thoughtless extension of the area under cultivation and the practice extensively in vogue of the tenants cutting down and in some cases altogether destroying the "sal" saplings for various domestic purposes. Many are the deleterious effects of this laying of violent hands on our forest wealth And the one conclusion to which they all point and which they emphasise is the need for Government stepping in with measures for checking that process in the interests of everyone concerned.

It is this need that provides the *raison d'etre* of the Chota Nagpur Private Forests Bill proposed to be introduced by the Prime Minister in the Bihar Assembly. Outwardly though they appear to constitute an encroachment into some of the rights hitherto enjoyed by the rightholders in the forest areas, the provisions of that Bill will command the approbation of all those who realise the necessity for preserving them as well as the dangerous consequences of suffering them to go to waste. Some of those provisions deserve to be drawn attention to in particular. One of them prohibits the rightholders from cutting down any class or species of trees in the forest area for fencing or other domestic purposes. The other enables the Government to take over a private forest under their management, as a "private protected forest," if it is found necessary in the public interest or if the prohibitions referred to above are considered insufficient to save the forest from being destroyed. The restriction of the rightholders' rights is, however, justified because their unrestricted exercise has hitherto led only to undesirable consequences. There is, however, the safeguard that the Government will not declare a forest as a "protected" one unless it is absolutely necessary in the public interest or in order to save the forest in the larger interests of the tenants. It should, therefore, always be possible for the owner of a forest to prevent its passing under

Government's control by adhering to the restrictions and conditions imposed.

It is necessary for those who look upon the Bill with disfavour to make an effort to understand and recognise the implications of it and the advantages that will be derived therefrom. If the Bill is passed into law, some of those who have, till now, so carelessly contributed to the destruction of the forests would not certainly be able to do so hereafter with the same impunity as before. But if Government take a private forest under their control as a "private protected forest," the landlord for one is expected to secure a steady and increasing income from the property. The tenants for another will be able to satisfy their reasonable requirements not only in fuel but in timber for housebuilding and agricultural purposes. There will not, of course, be scope or possibility for indiscriminate cutting down of sal saplings or bamboo culms and so on. More than all these, a well-planned policy of forest preservation will lead to the improvement in the climate of the area, in the steadying of its rainfall, in increasing the timber reserves of the province and so on. Government control will automatically lead to scientific management of the forests while the profits from the management will be handed over to the owners of the forest after the expenses of the management have been deducted. Chota Nagpur is at present economically backward; but here is a source of potential wealth to the area which awaits to be exploited and which can be exploited to the immense advantage of every one. Government management is the only method of preventing what Dr. R. K. Mukherji called the "eastward advance of the desert" in India and, in Chota Nagpur in particular, of preventing the over-flooding of the plains in Hazaribagh and Gaya Districts that generally occurs.—*Indian Nation*, Patna, dated the 3rd October, 1939.

TOWN FORESTS THAT PAY

By William Seabrook

[*Condensed from "Events:" A Monthly Review of World Affairs*]

When the children of Russell, Mass., grow up, they will live in their town tax-free. Town costs will be borne by Russell's town forest, which was begun only 15 years ago with less than 100 acres

and an appropriation of $100. Russell is just one of the 1,800 American towns that own forests. These forests cover 3,000,000 acres in 27 states, and their number has more than doubled since 1933. Why? Because they pay. And because almost any town can have one.

Town forests have been common from time immemorial in Europe. Two thirds of all the forest land in Switzerland is owned by local communities; in Bulgaria more than half; in Germany a vast part of its famous Black Forest; in France and Scandinavian countries, more than one-fifth of all the woodland.

Prior to 1900, we had only a few small ones in the United States. They were in New Hampshire, and they had been supplying fuel, money and timber since colonial times. In 1913 Massachusetts passed the first state law encouraging town forests; other states have followed, and to-day the idea is solidly established. New York State has 579; California has 158 and Pennsylvania 134. Several states in the South and Midwest have upwards of 20, and the map of New England is peppered with them.

The great State and National forests are primarily conservation and recreation projects, and are supported as such from the public funds. Town forests are expected not only to support themselves, but actually to contribute to the town coffers.

And they do. If partially wooded when acquired, they pay small dividends immediately. Cordwood, produced by thinning the stands—a process which increases the forest's value—yields additional revenue as the trees grow. And within the lifetime of the men who planted the trees comes lumber, and the really important money.

In America's town forests one begins to understand what "silviculture" really means. The towns cultivate their forests as a good farmer cultivates his land, planting, thinning, harvesting, always increasing values. In no town forests are the trees ever completely cleared away, as is the case with too many private timber tracts. Some town forests have recreation facilities, picnic grounds, bridle-paths and ski trails. These are pleasant by-products. But the main objectives are profitable harvesting and the protection of reservoirs and watersheds.

How is a town forest acquired? In my recent tour of the town forests of New England, I put this question to Gene Parks, selectman of the town of Russell, whose forest had grown from 100 to 3,000 acres in 15 years.

"Well," he said, "in our case it was maybe what you'd call a 'Yankee trick,' except that everybody was benefited and nobody cheated." Fifteen years ago, there were many abandoned farms near Russell whose taxes were a burden to the owners. It was costing the town plenty to keep roads open in winter and get the kids to school for the few struggling families that remained. So the Town Fathers used the money to move the backwoods families to good land nearer town. Everybody was happy, and the abandoned farms became the town forest. Most of it was already wooded. The open fields were planted with 246,000 young pines. The forest, said Mr. Parks, was already paying and when his grandchildren grew up, after the lumber came in, they would live tax free in Russell.

I had always supposed that it took a hundred years or more to make a tree of any size. But at Westfield, Mass., I was shown a prize spot planted less than 20 years ago in red pine. The trees, set out with checkerboard precision, are now more than 20 feet tall; they have been pruned up to about 12 feet, so their upper branches make a solid green roof, pierced only by sharp shafts of sunlight, slanting. It was like being in a cathedral. This lovely spot is already producing thousands of cords of firewood, which pays for upkeep and allows a small profit. Westfield also plans to eliminate local taxes, with an eventual lumber revenue of $20,000 a year. About 3,000 cords of fuel are cut each year from the town's 5,600 acres; figuring $2 profit per cord, that's $6,000 a year already.

In Westfield, as in other towns owning forests, those out of work or on relief can have free firewood. In my own village, which has plenty of privately owned woodland but no town forest, we have to pay for charity fuel and deliver it to the needy man's door. Towns owning forests kindly lend him an axe! They say, "The wood you cut yourself warms you twice!"

Professor R. P. Holdsworth, head of the Forestry Department in the State College at Amherst, is a leader in the town forest movement. "Why man," he exclaimed, "I could preach you a whole

sermon on town forests." I asked. "What would your text be?" He replied, "They pay!"

"They pay," said he, "not merely in dollars and cents, but in a deep social and spiritual way. In rundown rural communities, what was once a source of wealth can be made so again. When town forests are managed as crop units, they can produce annual yields of firewood, and yields of lumber every five years. When a wood is razed the brickyard or whatever industry had been depending on it must either move away or pay high freight and go broke. With a permanent supply of firewood and lumber, local industry has a permanent future.

"The last time I was in Sweden I saw a 22,000-acre forest which had been in danger of extinction. Sawmills would move into a locality, cut it all to the ground and move away. A while back the Government insisted that it be operated as a community forest. And I'll never forget the big permanent sawmill they've built there now. Instead of portable tin stacks that come down, it has a brick smoke-stack, like a factory, 110 feet high. There's a symbol for you! They will always have lumber to cut. The forest will always be there."

I told Professor Holdsworth of my surprise at the fact that town forests, even the little ones, began to pay so quickly. He said:

"Don't let your enthusiasm blind you to the fact that the real dividends are in the future and that the grandest results come with the passing of centuries. We are only beginning something that somebody else will finish after we are dead. That's what I mean when I say the first big dividends are spiritual. Working with trees we envision the future in longer terms than our own brief lives. Town forests are teaching this lesson, by example, to owners of private wood tracts. I know an old farmer who is tending a 50-acre stand of pines to send his baby grandson through college, *precisely because he knows he'll be dead himself before the boy or the trees have grown up.* Town forests are doing more than anything else to imbue the private timber owners of this too-rich nation with the new spirit of conservation."

At Durham, New Hampshire, the local forest is operated exclusively for school funds. In 1900 Olinthus Doe clinched his

name's immortality by bequeathing 80 acres of woods to the town. It has given the community a picnic spot, a source of fuel for the needy, and a steady small revenue from the sale of fuel wood and Christmas trees. New trees, 15,000 at a time, are furnished without charge from the state nurseries and planted by townspeople. So the forest is more valuable than it was when the late Olinthus bequeathed it.

New Hampshire's 101 town forests now total 20,000 acres, varying in size from four acres at Brentwood to 3,580 at Gorham. The state also has the oldest town forest in America, established at Newington in 1710. The forest has supplied all the fuel wood and building lumber of Newington for two-and-a-quarter centuries—yet there it stands, still thickly wooded and luxurious. America's nearest replica of Europe's traditional Fairy Tale forests. When Newington's church bell cracked a while back (around 1770), it was carted by ox team to Boston, recast and repaired by a chap named Paul Revere, who was paid with money earned out of that forest. If the bell cracks again, the forest can still pay for it.

Vermont's State Forester, Perry H. Merrill, had more news from Sweden. By the new forest laws over there, all timber land *even though privately owned*, must be managed in such a way that future growth is not hazarded. About the only forests in America which were consistently doing that, he said, belong to towns and communities. "Our Vermont prosperity and economic future," he said, "are bound up in forests. We have more than 500 big industrial establishments which depend solely upon forestry for their raw materials."

He told me Vermont now had 44 town and community forests, over 10,000 acres in all. Notably successful is the one at Essex Junction, a village of 1,600 people, which started buying forest land in 1890. In all, they have bought 800 acres for $10,000. Profit from the forest has paid that off and cleared $3,000 besides. Rutland's 4,000-acre forest was purchased for $60,000 in 1910, to insure the city's water supply. They have been planting 50,000 new trees every year for the past 20 years. During the past five years this forest has paid over $11,000 interest on the investment.

As I walked through the cathedral aisles of these forests, shot through with arrows of sunlight, carpeted with pine needles, I thought, "Why any boy could do it, and live to enjoy, in his own later years, the forest he created?"

So could almost any town. More and more states are coming to realize the importance of small, community-owned forests, and are passing laws to encourage them. Your own state forester can probably tell you how you can start one in your town. If he can't the U.S. Forest Service, in Washington, can. Your town could not make a better investment for its future. If humanity survives, trees too must survive. Our destinies are interlocked, and parallel.—*The Reader's Digest.*

The following information is taken from the statement relating to the

IMPORTS

ARTICLES	QUANTITY					
	MONTH OF JANUARY			10 MONTHS, 1ST APRIL TO 31ST JANUARY		
	1938	1939	1940	1937-38	1938-39	1939-40
WOOD AND TIMBER						
Teakwood—						
From Siam (cubic tons)	189	43	..	879	775	30
,, French Indo-China (cubic tons) ..	100	144	..	1,845	3,433	3,046
,, Burma (cubic tons)	13,403	10,128	11,531	1,33,456	1,27,286	1,29,180
,, Java (cubic tons)	761	481	..	4,383	2,863	2,460
,, Other countries (cubic tons) ..	25	16	..	637	36	..
Total ..	14,478	10,812	11,531	1,41,200	1,34,393	1,34,716
Other than Teak—						
Softwoods (cubic tons)	1,893	1,348	283	17,044	13,814	7,792
Matchwoods (cubic tons) ..	1,002	758	..	8,669	7,550	5,062
Total ..	2,895	2,106	283	25,713	21,364	12,854
Unspecified (value) ..	..	..	..	..	..	..
Firewood (tons) ..	76	42	112	527	600	501
Sandalwood (tons) ..	..	5	..	119	146	121
Sleepers of wood (tons)	21	46	56	662	323	1,272
Plywood (tons) ..	648	605	322	4,500	5,161	4,895
Manufactures of Wood and Timber—						
Furniture and Cabinetware ..	..	..	..	..	..	..
Other manufactures of wood (value) ..	..	..	..	..	..	..
Total of Wood and Timber (value) ..	..	..	..	..	..	..
Other Products of Wood and Timber—						
Wood pulp (cwt.) ..	9,102	28,001	64,485	1,63,348	2,41,420	1,86,335

Seaborne Trade and Navigation of British India for January, 1940:

IMPORTS

ARTICLES	VALUE (Rupees)					
	MONTH OF JANUARY			10 MONTHS, 1ST APRIL TO 31ST JANUARY		
	1938	1939	1940	1937-38	1938-39	1939-40
WOOD AND TIMBER Teakwood— From Siam ..	24,761	5,420	..	1,13,450	1,00,565	3,336
„ French Indo-China ..	13,761	14,914	..	2,14,986	4,13,316	3,30,406
„ Burma ..	17,64,841	12,94,231	14,01,991	1,71,53,676	1,68,08,517	1,63,22,275
„ Java ..	99,859	54,909		5,62,389	2,94,683	2,60,863
„ Other countries	3,232	2,609	..	71,218	5,100	..
Total ..	19,06,454	13,72,083	14,01,991	1,81,15,719	1,76,22,191	1,69,16,880
Other than Teak— Softwoods ..	1,44,837	85,832	34,414	12,88,956	9,79,093	5,47,267
Matchwoods ..	57,722	43,829	..	5,34,229	4,92,208	3,51,834
Total ..	2,02,559	1,29,661	34,414	18,23,185	14,71,301	8,99,101
Unspecified	3,86,611	2,23,543	1,74,467	23,78,082	26,32,221	21,85,810
Firewood ..	1,140	635	1,933	7,908	7,439	7,789
Sandalwood ..	247	2,533	.	35,235	37,438	34,274
Sleepers of wood ..	1,336	5,190	7,239	81,593	47,751	1,68,980
Plywood ..	1,47,709	1,12,768	76,570	9,76,077	10,70,130	9,60,101
Manufactures of Wood and Timber— Furniture and Cabinetware ..	1,53,976	1,21,857	95,921	18,55,251	13,54,493	10,69,520
Other manufactures of wood ..	2,43,379	1,42,659	1,39,104	15,74,002	13,61,021	12,19,206
Total of Wood and Timber ..	28,89,435	19,89,072	18,35,718	2,49,91,801	2,42,49,492	2,23,92,141
Other Products of Wood and Timber— Wood pulp ..	76,325	2,67,859	7,56,787	12,51,006	22,64,635	16,26,331

EXPORTS

ARTICLES	QUANTITY					
	MONTH OF JANUARY			10 MONTHS, 1ST APRIL TO 31ST JANUARY		
	1938	1939	1940	1937-38	1938-39	1939-40
WOOD AND TIMBER						
Teakwood (cubic tons)—						
To United Kingdom	..	10	..	207	47	20
,, Germany ..	..	..	..	..	1	..
,, Iraq ..	13	8	17	172	200	301
,, Ceylon ..	3	..	..	4	2	30
,, Union of South Africa ..	..	..	..	..	..	..
,, Portuguese East Africa ..	..	..	..	..	..	..
,, United States of America ..	..	..	..	..	..	..
,, Other countries	115	25	65	728	1,731	1,188
Total ..	131	43	82	1,121	1,971	1,539
Teak keys (tons) ..	..	..	..	..	..	..
Hardwoods other than teak (cubic tons) ..	..	2	..	15	2	..
Unspecified (value) ..	..	..	..	..	..	..
Firewood (tons) ..	51	..	..	167	..	2
Total ..	51	2	..	182	2	2
Sandalwood (tons)—						
To United Kingdom	3	2	..	17	13	..
,, Japan ..	11	2	24	65	45	95
,, United States of America ..	103	7	..	538	319	501
,, Other countries	27	22	29	292	160	252
Total ..	144	33	53	912	537	848
Manufactures of Wood and Timber—						
Furniture and Cabinetware (value)	..	..	..	..	..	..
Other Manufactures of Wood and Timber (value)	..	..	..	..	..	..
Total of Wood and Timber—	..	..	..	..	..	..

EXPORTS

ARTICLES	VALUE (RUPEES)					
	Month of January			10 Months, 1st April to 31st January		
	1938	1939	1940	1937-38	1938-39	1939-40
Wood and Timber						
Teakwood—						
To United Kingdom	..	1,250	..	28,166	5,969	2,600
„ Germany ..	..	..	..	..	150	..
„ Iraq ..	880	1,660	2,310	30,352	56,941	59,239
„ Ceylon ..	120	36	..	266	343	2,145
„ Union of South Africa ..	..	..	..	..	..	..
„ Portuguese East Africa ..	..	..	..	..	..	..
„ United States of America ..	..	..	..	..	..	..
„ Other countries	29,509	6,980	9,753	2,06,459	6,25,029	2,49,302
Total ..	30,509	9,926	12,063	2,65,243	6,88,432	3,13,286
Teak keys ..	..	..	..	..	..	..
Hardwoods other than teak ..	..	350	..	4,020	422	..
Unspecified ..	70,855	18,488	20,037	10,78,310	2,51,687	2,21,403
Firewood ..	700	..	..	1,735	..	16
Total ..	71,555	18,838	22,037	10,84,065	2,52,109	2,21,419
Sandalwood—						
To United Kingdom	3,350	2,200	..	18,030	14,580	..
„ Japan ..	13,070	2,250	25,463	64,680	47,533	99,488
„ United States of America ..	1,11,775	3,900	..	5,45,715	3,24,380	5,19,310
„ Other countries	27,192	20,945	25,530	2,92,914	1,52,488	2,36,059
Total ..	1,55,387	29,295	50,993	9,21,339	5,38,981	8,54,857
Manufactures of Wood and Timber—						
Furniture and Cabinetware ..	10,332	9,794	7,655	95,561	2,88,495	3,20,288
Other Manufactures of Wood and Timber ..	28,093	57,283	25,950	2,52,238	4,50,676	3,08,252
Total value of Wood and Timber ..	2,85,544	1,15,342	1,11,043	25,22,885	19,30,198	16,97,814

INDIAN FORESTER

MAY, 1940

THREE NEW GENERA OF INDIAN GRASSES

BY N. L. BOR

While engaged upon a critical study of Indian Gramineae, with special reference to those of Assam, it became clear that the erection of certain new genera to accommodate species which have been placed in other genera on very superficial grounds, was justified. In addition to *Narenga* Bor and *Eragrostiella* Bor, which have representatives all over India, *Pseudodichanthium* Bor for a species confined to Bombay is also proposed.

As the first two genera are being adopted in Vol. V, Flora of Assam, they are being published in advance in accordance with custom.

1. NARENGA BOR

Narenga Bor; genus novum graminearum distinctum, a *Saccharo* Linn. glumis inferioribus prorsus coriaceis, glumis superioribus (apice memberanceo excepto) etiam coriaceis, distinguendum.

NARENGA BOR

Spiculae omnes similes, binae, una sessilis, altera pedicellata, rhachi articulata racemorum paniculatorum dispositae; pedicellatae a pedicello solutae, sessiles cum rhacheos articulo accumbente pedicelloque demum decidentes. *Anthoecia* 2, inferius ad lemma reductum, superius hermaphroditum. *Glumae* aequales, coriaceae vel secundaria apice membranacea; inferior dorsi plana, marginibus involutis, breviter ciliatis; superior carinata, apice membranacea. *Lemmata* hyalina; superius truncatum, paleatum, sine arista. *Lodiculae* 2. *Stamina* 3, lateraliter exserta.

Gramina perennia, alta, foliis planis, scabris. *Culmi* nodis dense barbati. Panicula angusta, densa; pili spiculis breviores.

NARENGA BOR

Spikelets all alike, 2-nate, one sessile the other pedicelled on the articulate fragile rhachis of panicled racemes, the pedicelled falling from their pedicels, the sessile together with the contiguous joint of the rhachis and pedicel. *Florets* 2; the lower reduced to an empty lemma; upper hermaphrodite *Glumes* equal in length, coriaceous, brown, shining; lower flat on the back, margins laxly inflexed, short haired on the margins; upper keeled, membranous at the top. *Lemmas* hyaline; upper truncate, awnless, paleate. *Lodicules* 2. *Stamens* 3. Stigmas laterally exserted.

Tall perennial grasses with long flat scabrid leaves. *Culms* densely bearded at the nodes. Panicle narrow dense; hairs shorter than the spikelets. Type species *Saccharum narenga* Wall.

One new combination is necessary.

Narenga porphyrocoma (*Hance*) *Bor* comb. nov. Syn. Saccharum narenga Wall. Cat. no. 8856; Eriochrysis narenga Nees ex Steud., Syn. Pl. Glum. (1854) 411; Eriochrysis porphyrocoma H. F. Hance, Jour. Bot. XIV (1876) 294; Saccharum porphyrocomum (Hance) Hack., Mon. Androp. (1889) 120.

It has long been felt by agrostologists that the retention of *Saccharum narenga* Wall. in the genus *Saccharum* was anomalous owing to its possession of morphological characters which are quite distinct from those of species accepted as members of that genus. The most important of these is the coriaceous glumes (slightly membranous at the tip in the case of the upper glume) in contrast to the membranous glumes, at most slightly coriaceous at the base, of the other species.

The late Dr. Otto Stapf treated *S. narenga* as a distinct genus in the Kew Herbarium. Dr. G. Bremer [Proceedings of the Third Congress of the International Society of Sugar Cane Technologists, (1930) 408] remarks: "It must be stated, however, that *Saccharum narenga* has only 15 chromosomes in the haploid phase. According to Professor Jeswiet it is uncertain whether this species is indeed a *Saccharum,* since it is a grass with external characters that differ in a certain degree from those of *Saccharum*." I. H. Burkill [Economic Products of the Malay Peninsula, II, (1935) 1923] states under *Saccharum* "It must be explained that the delimitation of *Saccharum* from the most closely allied genera has undergone changes recently by which, in the first place, the genus, as it stood in the Flora of British India in 1897, has been divided into three genera: (1) *Saccharum,* which includes *S. spontaneum* Linn. and *S. arundinaceum* Retz.; (2) *Narenga,* into which *S. narenga,* Buch-Ham. has been transferred and (3) *Sclerostachya* with *S. fuscum* Roxb. and *S. ridleyi* Hack." I have been unable to find any reference in the literature to the creation of a genus to include *S. narenga* and Mr. C. E. Hubbard of Kew has not been able to throw any light upon this question.

As *Narenga* cannot be used for the specific epithet the next available is "*porphyrocoma*" since *Eriochrysis porphyrocoma* Hance, is a synonym of *Saccharum narenga* Wall. Hackel kept *Saccharum porphyrocomum* (Hance) Hack. (*Eriochrysis porphyrocoma* Hance) distinct in his monograph on the *Andropogoneae* but he did not see Hance's specimens and only copied his description.

Dr. E. K. Janaki Ammal has been good enough to place at my disposal the result of her researches into the cytology of *Saccharum* and closely allied genera.

Saccharum arundinaceum	.. 2n = 40.
S. officinarum	.. 2n = 80.
Sclerostachya fusca	.. 2n = 48 and 96.
Imperata cylindrica	.. 2n = 20.
Narenga porphyrocoma	.. 2n = 30.

Saccharum spontaneum [E. J. Janaki Ammal, Ind. Jour. Agric. Sc. VI (1936) 1], in so far as its Indian forms are concerned, has been shown to form a polyploid series with the following chromosome numbers 2n = 48, 56, 64, 80.

2. ERAGROSTIELLA Bor.

ERAGROSTIELLA Bor; genus novum graminacearum Eragrosti Beauv. affinis, a qua culmis gracilibus dense caespitosis et spiculis in racemis longis, terminalibus, simplicibus dispositis, distinguitur.

ERAGROSTIELLA Bor.

Spiculae lineares vel ovato-oblongae, leviter vel valde lateraliter compressae, sub-secundae, sub-sessiles vel breviter pedicellatae, in racemis longis, terminalibus, simplicibus, gracilibus, laxae vel imbricatae dispositae; rhachilla continua vel inter anthoecia tarde disarticulans, internodiis glabris, angulatis, superne leviter incrassatis. Anthoecia 6-20, hermaphrodita vel summum sterile et plus minusve redactum. *Glumae* aequales, vel superior longior, carinatae; inferior 1-nervia, superior 3-nervia; lemmata imbricata, ovata vel lanceolata, apice mutica, dorso leviter vel valde carinata vel rotundata, acuta vel obtusa, membranacea vel chartacea, glabra; paleae lemmatibus subaequilongae, vel paullo breviores, bicarinatae; carinae plus minusve alatae. *Stamina* 3. *Ovarium* glabrum. *Lodiculae* 2, cuneatae, carnulosae. *Styli* distincti, terminales; stigmata plumosa, ex anthoeciis lateraliter exserta.

Gramina perennia, dense caespitosa; vaginae basales persistentes; foliorum laminae angustae, filiformes, rare latae, coriaceae.

ERAGROSTIELLA Bor.

Spikelets linear to ovate-oblong, strongly or slightly compressed, shortly pedicelled or sub-sessile, in two rows, distant or crowded, in long, slender, terminal racemes; rhachilla tough, persistent, or tardily breaking up, glabrous, angled, slightly swollen at the top of the joint. *Florets* 6-20, hermaphrodite, or the uppermost more or less reduced. *Glumes* sub-equal, or the upper the longer, keeled, deciduous, the lower 1-nerved, the upper 3-nerved, glabrous; lemmas imbricate, ovate or lanceolate, slightly or strongly keeled on the back, acute or obtuse, membranous or chartaceous, glabrous; palea as long as the lemma, keeled, winged on the keels or not, often persistent on the rhachilla. *Lodicules* 2, small, cuneate, fleshy. *Stamens* 3. *Ovary* glabrous; style distant, terminal; stigmas plumose laterally exserted.

Perennial grasses, densely caespitose; leaves mostly convolute, filiform, rarely flat; ligule short; base of the culm covered with the remains of old sheaths. Type species *Eragrostis leioptera* Stapf.

The genus *Eragrostiella* comprises a number of grasses which have been hitherto included in *Eragrostis* but which differ very markedly in inflorescence and habit from the very great majority of the species in that genus. The main characteristics of the species placed in *Eragrostiella* are the spicate inflorescence and the tufted habit. Bentham in Jour. Linn. Soc. XIX (1882) 116 placed all these forms and the very different *Eragrostis cynosuroides* Beauv. in one section of *Eragrosteæ* which he called *Plagiostachya*. Hook. f. in F.B.I. VII (1897) 324 separated *E. cynosuroides* Beauv. from the rest and placed it in a special section *Desmostachya* and retained the section *Plagiostachya* for those grasses with a spicate inflorescence. Stapf subsequently raised *Desmostachya* to generic rank and *Eragrostis cynosuroides* became *Desmostachya bipinnata* (Linn.) Stapf. There is no reason why *Plagiostachya* (of Hook. f.) should be maintained any longer as a section of the genus *Eragrostis* and I propose to raise it to generic rank under the name *Eragrostiella* Bor.

The following new combinations of Indian grasses are necessary: *Eragrostiella leioptera* (Stapf) Bor, comb. nov.; *E. bifaria* (Vahl) Bor, comb. nov.; *E. brachyphylla* (Stapf) Bor, comb. nov.; *E. walkeri* (Stapf) Bor, comb. nov.; *E. collettii* (Stapf) Bor, comb. nov.; *E. nardoides* (Trin.) Bor, comb. nov.; *E. secunda* (Nees) Bor, comb. nov.

3. *PSEUDODICHANTHIUM* Bor.

Pseudodichanthium Bor; genus novum distinctum, nulla affinitate obvia sed a *Dichanthio* Willemet, ad quod ob spiculas imbricatas et eas infimas saepissime neutras a Stapfio et aliis referendum est, racemo solitario breve et gluma inferiore spiculae sessilis late alata satis recedit.

PSEUDODICHANTHIUM Bor.

Spiculae arcte imbricatae vel summae subdivergentes, stramineae, glaberrimae, scariosae, in racemis solitariis brevibusque culmorum et ramorum apicibus dispositae; articuli inter nodos 2 vel 3 infimos continui, breves, teretes, glabri, caeteri longiores, fragiles, sub-clavati, margine exteriore sericeo-ciliati; pedicelli infimi brevissimi, glabri, caeteri longiores, e basi angusta clavati, sub-flexuosi, margine una dense sericeo-ciliati, alterâ in dentem lanceolatum producti. Spiculae sessiles hermaphroditae (nisi infima saepissime neutra); gluma inferior scariosa, late alata, marginibus angustissimis inflexis; superior inferiore brevior, chartacea vel papyracea. Anthoecium inferum vacuum; lemma oblongum, obtusum, hyalinum, epaleatum. Anthoecium superum hermaphroditum; lemma stipitiforme, ad basin aristae hyalinam redactum; aristae columna valde torta. Spiculae pedicellatae sessilibus similes, sed neutrae longioresque, paulo obliquae. Stamina 3. Caryopsis oblonga, compressa.

Gramina annua, gregaria. Culmi graciles, e basi tenui adscendentes. Foliorum laminae anguste lineares, plus minusve hirsutae; vaginae glabrae.

PSEUDODICHANTHIUM Bor.

Spikelets much imbricate, or the upper subdivergent, stramineous, scarious, very glabrous, arranged in short solitary racemes terminating the culms and branches; lowest 2 or 3 joints short, continuous, cylindrical, glabrous, the others long, subclavate, disarticulating, sericeous-ciliate on the outer margin; lowest pedicels very short, glabrous, the remainder longer, clavate from a narrow base, subflexuous, densely ciliate on one edge, the other being produced into a lanceolate tooth. Sessile spikelets hermaphrodite (the lowest

often neuter); lower glume scarious, broadly winged, margins narrowly inflexed; the upper shorter than the lower, chartaceous or papyraceous. Lower floret empty; lemma oblong, obtuse, hyaline, epaleate. Upper floret hermaphrodite; lemma reduced to the hyaline stipitate base of an awn; base of the awn strongly twisted. Pedicelled spikelets similar to the sessile but longer and neuter, somewhat oblique. Stamens 3. Caryopsis oblong, compressed.

Annual gregarious grasses. Culms slender, ascending from a slender base. Leaf-blades narrowly linear, more or less hirsute; sheaths glabrous. Type species *Andropogon serrafalcoides* Cooke et Stapf.

The following new combination is necessary:

Pseudodichanthium serrafalcoides (Cooke et Stapf) Bor comb. nov. Syn. Andropogon cookei Stapf ex Woodrow in Journ. Bomb. Nat. Hist. Soc. XIII, (1893) 438 (nomen tantum). A. (Dichanthium) serrafalcoides Cooke et Stapf in Kew Bull. (1908) 450. Dichanthium serrafalcoides Blatt. et McCann in Journ. Bomb. Nat. Hist. Soc. XXXII (1928) 426.

This species has been forced into the genus *Dichanthium* although its inclusion in it has been considered anomalous by all botanists who have dealt with it. It is very different from *Dichanthium* in appearance, in the texture and disposition of the glumes, in the pedicelled spikelet being larger than the sessile, and in the winged lower glumes. It resembles the genus only in the imbricate spikelets and the lowest sessile and pedicelled spikelets being often homogamous. The differences outweigh by far the similarities and the creation of a genus to accommodate this plant seems fully justified.

It may be mentioned here that *Pseudodichanthium* has some affinities with the genus *Heteropogon*. In the latter the lower few joints of the raceme disarticulate very tardily or not at all, the lower spikelets are homogamous and the spikelets are imbricate; the sessile spikelet has, however, a totally different structure.

KARNPUR AND BINDRABAN BAMBOO FORESTS

PART I

My Experiences of Their Management

BY MIAN SAEED AHMAD, FOREST RANGER, PUNJAB.

Dendrocalamus strictus covers an area of 6,570 acres of low hills in the Dasuya Tahsil of Hoshiarpur District, Punjab, in two compact blocks of reserved forests, Karnpur and Bindraban. The names of these blocks owe their origin, in case of reserve Karnpur to the Raja Karn of ancient history, whose elephants used to be kept and fed in this forest at a place called "Hathi thán" (abode of elephants) in the middle of the forest, and to the renowned temple of Guru Gorakh Nath called Bindraban, situated in the middle of reserve Bindraban. Physiographically these lie over the north-western end of the Siwalik range but on a distinct geological formation of loose conglomerate overlaid by riverain gravels, on elevation varying from 1,000 to 2,500 feet above sea level. Bamboos predominate over 4,223 acres, the rest being mostly scrub occurring at the extreme end of the range and along the verges of the forests. The average annual rainfall works out to 55.86 inches, mainly falling from July to September, and the record of rainfall indicates that two years of normal fall alternate with one of shortage.

Past History

The forests passed to the Government from the Sikhs, and prior to their transfer to the Forest Department, their management was in the hands of the district authorities. The Department took over the control in 1866 and due to the complicated nature of dealings with the people the entire system of management was revised. In 1879 these were gazetted as 'Reserved Forests' with provisions for the exercise of rights by the inhabitants of the surrounding 32 villages, 16 in each case. There is hardly any need to dilate here on all that happened from that date up to 1903 when the first working plan was brought into force. Suffice it to say, that in 1903 the extent to which the rights of the people were admitted in these forests amounted to:—

(*i*) Grazing of all kinds of animals in both the forests throughout the year, except the 3 months of the monsoons.

(*ii*) Removal of firewood from open portions.

(*iii*) Receiving bamboos for bona fide use on payment of the cost of cutting and carriage to depots.

The customary practice of lopping bamboos then prevalent was put a stop to by a surrender, by the Government, of the right to close by rotation half of Karnpur and 2/3rds of Bindraban throughout the year; and also, the department was given a right to

impose small closures for purposes of artificial regeneration when and where necessary. The systematic working of these forests thus commenced from 1903 on a regular working plan prepared by Mr. Hart with the following definite objects in view:

(*a*) Improvement of growing stock culturally and by working the forests up to the full possibility.

(*b*) Artificial restocking of blank or poorly stocked areas.

(*c*) Provision for a sustained annual yield to be utilised with advantage to the rest of the crop, and without jeopardising the interests of the right-holders.

(*d*) Provision for the due exercise of rights by the people without endangering the very existence of these forests.

Since then management of these bamboo forests has passed through various phases.

In 1903, Hart mentioned that except where clump clearing had been done the clumps were generally very congested, choked with dead and malformed shoots, a result brought about to some extent by the past treatment, but due mainly to insufficient cutting. With the belief that frequent cutting was beneficial to the clumps in avoiding congestion, stimulating regeneration and retarding gregarious flowering, he prescribed annual cuttings without cleanings, as he held that with the latter operation it would be impossible to dispose of all the available stock with a poor market. The demand in the closing years of the period, however, accelerated on account of the Great War and therefore clump cleaning was also carried out in some portions. The experience gained showed that cleanings stimulated the annual production of bamboos and such areas gave a higher yield than uncleaned areas.

The first revision of this plan was done by Mr. Walters in 1922 who then considered that clumps cut over every year very rapidly deteriorate while those cut over at long intervals show decided improvement. He therefore discussed the possibility of a 3 years' and even 4 years' cycle, but considering that cutting is only confined to shoots of not less than 3 years of age and also the rapidity with which congestion sets in, prescribed biennial fellings preceded by cleanings wherever necessary, because he thought that the forests were still generally very congested and so a longer cycle would be harmful. This in spite of the fact that in the course of an annual felling cycle working for a period of about 18 years the output had varied from 5 to 12 lacs bamboos or averaging to 7 lacs per annum.

During the currency of Walters' plan fellings were however still further curtailed from 1927-28, and from a workable area of 4,223

acres under the biennial cycle nearly $2\frac{1}{4}$ lacs bamboos were annually extracted, which hardly works out to $1\frac{1}{4}$ bamboos per clump on an average density of 85 clumps per acre, based on countings made over large areas.

In a subsequent revision of the working plan by Mr. Mohan, brought into force from 1933-34, further restriction was imposed on the extent of annual fellings, and without a change in the felling cycle the exploitable number was fixed at 2 lacs of bamboos from both these forests. This prescription was the cause of a revolt from the prevalent system of working these bamboo forests. A glance at the history of exploitation ranging from 1909-10 to 1938-39 would show how the intensity of fellings in these forests has varied from year to year.

Years.	Bamboos sold and given to right-holders.	Expenditure on bamboos sold.	Revenue realised from sales.	REMARKS.
		Rs.	Rs.	
1909-10 ..	492,634	Figures not available.		
1910-11 ..	377,264			
1911-12 ..	667,011			
1912-13 .	466,222			
1913-14 ..	423,162			
1914-15 ..	212,627			
1915-16 ..	624,123			
1916-17 ..	628,526			
1917-18 ..	1,167,932			
1918-19 ..	1,229,067			
1919-20 ..	880,290			
1920-21 ..	689,175	19,477	38,081	Period of departmental fashioning, carriage, etc. and sales.
1921-22 ..	855,712	28,654	35,539	
1922-23 ..	798,570	23,139	40,202	
1923-24 ..	656,580	19,194	54,583	
1924-25 ..	696,948	18,977	45,171	
1925-26 ..	686,546	15,955	40,758	
1926-27 ..	623,609	23,780	29,790	
1927-28 ..	211,268	7,870	28,030	
1928-29 ..	258,263	7,601	20,708	
1929-30 .	261,574	6,800	16,479	
1930-31 ..	195,035	5,642	11,132	
1931-32 ..	208,124	2,112	11,877	
1932-33 ..	236,135	2,729	12,728	
1933-34 ..	276,210	2,510	10,835	
1934-35 ..	212,394	1,978	9,041	
1935-36 ..	303,808	2,928	12,125	
1936-37 ..	439,087	6,128	19,583	
1937-38 ..	527,209	10,021	24,263	
1938-39 ..	524,402	13,855	21,895	

Note.—The distinct fall of output from 1927-28 is noticeable as also the increase made since 1935-36.

Mr. Glover's observation in his inspection note of 1933, (the relevant part of which is reproduced below), will show the effect of restricted operations from 1927-28 on these forests:
(*Figures I and II in plate 14 show results of such operations.*)

"There is very much over-congestion in many of the clumps and in Compartment No. 2 in Karnpur, where fellings have not taken place since 1929 congestion is so great that the production of fresh manus in 1933 is markedly inferior to that of other compartments where the clumps were more open. The more remote clumps are full of dead bamboos which should have been cut and sold long ago. Congestion appears to be due partly to the neglect of remote areas, partly to the natural disinclination of coolies to cut bamboos from an over-congested clump on account of the trouble involved; and, the effect of the restriction of output imposed in recent years has been to restrict fellings to the more accessible areas. Thinnings have been attempted and although the operation in itself is useful, it is impracticable to carry out thinnings on a larger scale as the output is not saleable. It is quite obvious that thinnings and cleanings must be done at the time when main fellings are carried out and each clump must be treated on its merits and left in proper condition. In fact the unit of working must be the individual clump and not the whole compartment. The limited output of the working plan prescription is working so as to result in the removal of the larger bamboos which command a better price and the number of small bamboos left in each clump is increasing, and clumps which possess only small bamboos have often not been felled at all."

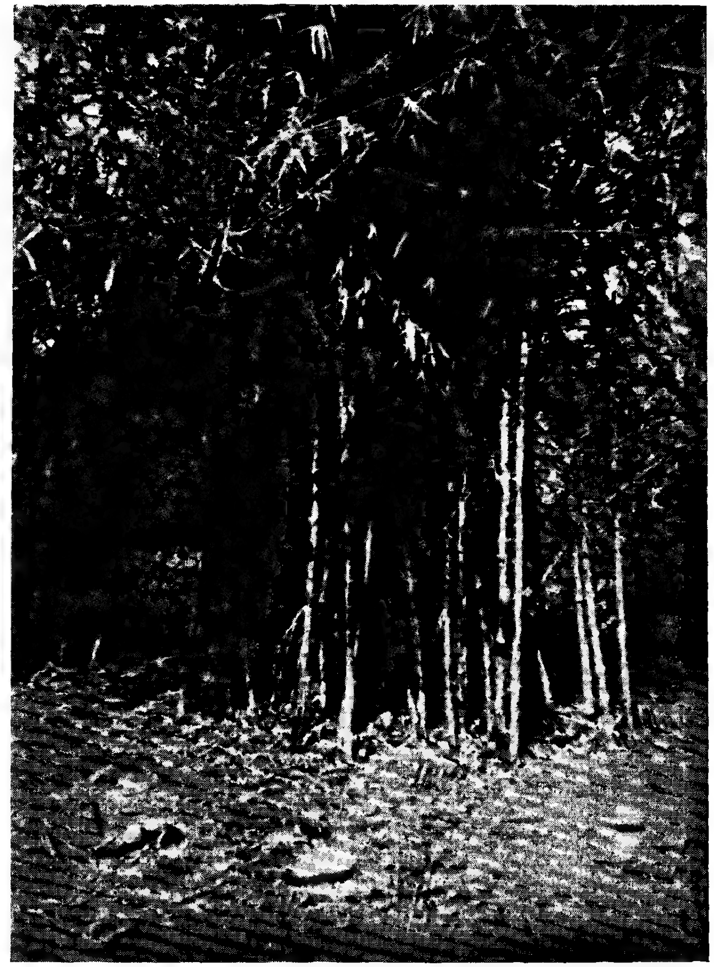
With the cultural depreciation of the growing stock, as described above, there had been another factor concerned with the forest management: unrestricted admission of rights particularly of grazing. This gave no scope for natural regeneration from seed for replenishment of the backward areas. On the other hand, the increase in population, here as elsewhere, after the original admission of rights of the 32 villages, which were just small hamlets then, meant a heavy stress on grazing and firewood by 32 big villages on a very limited area of the bamboo forests, and with no possibility of relief. To meet with this drawback efforts were made to restock the blanks or backward areas by direct sowings and planting of rhizomes by effecting small closures. This method, however, did not find

Fig. I

The results of past working are noticeable. This is a congested clump in R. F., Bindraban, which perhaps always escaped the attack of coolies and bore no shoot even three or four years old. It consisted mostly of dead and dying bamboos and a few overmature tangled into these.

Photo: Saeed Ahmad. (1935.)

Fig. II



Another congested clump along the roadside with choked interior in R. F., Karnpur; a result of past irregular system of working. The felling and consequent opening along the periphery had produced two manus in it.

Photo : Saeed Ahmad. (1935.)

favour and remained a failure till as late as 1928, after which the technique of artificial restocking of such areas was revised and a nursery was started for raising plants for the purposes of transplanting. Efforts made at this since 1931 are meeting with success. Direct sowing of khair (*Acacia catechu*) have also proved very successful in areas unfit for bamboo planting.

The basis of change.

The whole system was therefore to be recast because the congestion in these forests was so great that unless the outturn was largely increased much wastage of bamboos would occur. To implement this two plots of 100 acres each in the two forests (compartment 2 in Karnpur and compartment 5 in Bindraban) were experimentally taken up in the winter of 1933 and dealt with silviculturally. In doing so every clump was taken as a separate unit of work and all the saleable stock made available under thinnings was extracted; and besides about $1\frac{1}{3}$ lacs of bamboos sent to the market, numerous bamboos which were dead, dying, malformed and otherwise deteriorated, or choking the clumps, were cut and thrown away as useless. This mode of working not only yielded a good stock for sale (8 per clump on a basis of 85 clumps per acre) but also resulted in an ideal reproduction of manus during the ensuing monsoon (37 per cent.) compared with insignificant production in unworked areas (8 per cent). The system of felling was accordingly regularised, because it had amply justified itself to all the objects of management. It had decidedly improved the condition of the clumps by working them to their full possibility, it had resulted in better production, and last but not the least, it had resulted in the increase in gross revenue.

At this stage it will not be out of place to make a brief mention of the various stages of growth in the formation of a clump and its further development.

This species belongs to the natural Graminae order and is a typical perennial grass. On germination its plumule emerges out as a pointed bud with scale like leaves sheathing around it, and rapidly develops into a thin stem. From the first rhizome several short rhizomes are developed which curve up outwards and form aerial shoots. The rhizomes thus developed and the shoots springing from them become successively larger and larger. The earlier shoots

are thin, wiry and grass-like but ultimately woody culms are produced, the transition being very gradual. Normally the earlier shoots die off sooner or later, on being displaced by the larger and more vigorous shoots produced afterwards. The plant gradually spreads from the centre outwards, forming new rhizomes, which give forth new shoots and ultimately assumes the form of a clump with more vigorous individuals surviving under a natural thinning out process. Bamboos have a superficial root system and therefore even slight changes in soil moisture have great effect on the production which starts earlier in moist localities than in drier localities nearby. Thus production is particularly low along ridges. Manus or new culms appear after the monsoons break and continue generally up to the middle of September depending on the intensity of rainfall. These generally spring up from the last or the previous year's culms and in very favourable climatic conditions from 3 and 4-year-old culms. Individual rhizomes have been found to branch and produce up to 5 culms in the same season in these forests. They follow the line of least resistance and unless the clump is choked towards the centre there is no obstacle to the new culms coming up anywhere. Thus in a clump properly thinned and cleaned new rhizomes and their culms get enough room to develop in all directions. Generally, however, the new culms spring up along the periphery where the younger rhizomes are, and as culms are the source of food supply for the rhizomes, felling of outer younger culms to such an extent as to leave the rhizomes absolutely bare reduces their activity and ultimately may cause their death. Individual culms grow by elongation of internodes and the main period of growth varies from 3 weeks to about 2 months, both for length and girth, depending of course upon weather and the vigour of the rhizomes or the clumps in general. In Karnpur 50 manus were observed in 1936 and found to grow from 3″ to 1′-1″ per day: an average of 9″ per culm per day was finally worked out. In the case of Bindraban the rate or growth worked out to 7″ only. Culms springing up late do not reach full size for lack of optimum growing conditions and when coming up very late, towards the end of the monsoons, they have been found to remain as mere scaly cones only to die off later. Although it takes so short a time for a culm to attain its full size yet it requires two monsoons to pass over after production to full maturity, and 1 and 2-year-old

culms are considered as *katcha* (immature) and unmarketable. In their growing period culms are liable to be attacked by an insect (*Estigamina chinensis—chrysomelidæ*) which makes galleries inside the internodes and by a beetle (*Cyrtotrachelus longipes—Curucu lionidæ*) which destroys the growing terminal bud. Sickly living culms, or such half broken, or top dead, culms as are left to stand in the clumps are also liable to be attacked; and several such cases came to notice in the improperly worked clumps where the famous borer of cut bamboos (*Dionoderus ocellaris—Bostrychidæ*) had attacked such culms. In depots *Phæcilocerus pietis* is the other pest which completely riddles the cut bamboos whether raw or fashioned. This attack is most severe if immature bamboos are cut for storage. These insects hibernate in winter and emerge and attack culms as they develop, and the only practical remedy to eliminate the possibility of this attack is to cut and remove them, burning if possible. Then there is the *Chrotogonus* spp generally known as *Toka* and the Rice grass hopper (*Hiereoglyphus* spp) which attack the living bamboos, defoliate and eat them. An attack of this hopper in 1934 in the Karnpur forest was particularly heavy so that every seedling in the nurseries and every manu coming up was destroyed in the infested localities. Locusts also attacked Karnpur forest in the hot weather of 1924-25 and completely defoliated the clumps which then failed to respond and reproduce in the following rains. Drought and over-grazing are other factors which produce conditions directly affecting the growth of culms and the productivity of clumps.

These natural tendencies observed in the formation of a bamboo clump and the various stages of development it passes through sufficiently indicate that ridding of unhealthy, wiry and otherwise useless bamboos from a clump, with thinnings in the rest at proper intervals, not only eliminates the possibility of congestion but also accelerates the production of more vigorous bamboos and their even distribution throughout. The clump, our unit of work, is thus a selection forest on a small scale, containing dead, dying, malformed, suppressed and also healthy bamboos, mature as well as immature, to be dealt with silviculturally depending upon factors peculiar to itself. Such a silvicultural limit imposed on cutting ensures its upkeep and productivity on a sound basis and the method of treat-

ment has therefore to be applied accordingly: the method which may also retard gregarious flowering not so far known in the history of these forests, as a regular and proper working is likely to do.

The Change.

The change in the management was brought about by enforcing the following felling rules based on the above history of the past with all its consequences, and bearing on the general behaviour of the bamboo in its production and development:

"(1) Cleaning and felling of bamboos in the coupe must start from the top of the forest and continue towards the bottom, so that no area is left unworked, with the exception of the periphery where the growth is poor.

(2) Cleaning and felling must be carried out at the same time and not done separately.

(3) Fellings should commence by the beginning of November and must terminate by the end of February.

(4) Each clump must be treated as a unit of working, and the total number of bamboos to be felled in any clump should ordinarily be equal to the number of manus and the shoots of the previous year in that clump, but may exceed that number in congested clumps or be less in open clumps subject to the following restrictions:

(*a*) All old culms must not be felled.

(*b*) The older culms left should be evenly distributed over the clump.

(*c*) The young shoots must be provided with sufficient support by the retention of sufficient older bamboos particularly on the lower side on steep ground.

(5) No clump containing marketable bamboos should be left untreated during the course of the operations. All dead, dying, malformed and small bamboos must be removed. Dead bamboos should not be left to support young shoots.

(6) Bamboos on the periphery of the clump must be retained.

(7) All shoots should be cut within 6″ of the ground.

(8) No portion of the cut shoots may be left in the clump.

(9) Manus, or shoots of the previous year, may only be cut when malformed or required for tying bamboo bundles.

(10) Felling must be cautious on hot aspects and near the ridges or wherever the growth of bamboos is poor.

(11) Cleanings and fellings must be constantly supervised by a forest official capable of deciding the silvicultural limit of the operations."

These rules obviously ensure regular working throughout the area. With cleanings preceding fellings the area has to be gone over twice so that supervision becomes loose and there is very grave danger of the coolies tackling only those clumps which are more convenient, yield bigger sizes and pay them more. There is also the practical difficulty of moving through the forest over again, both for cutting the bamboos and for their carriage to depots after cutting, with the forest floor full of the waste material so thrown away, and particularly in a specific period of work to ensure safety from borers' attack, with a limited quantity of labour. Each clump is prescribed as a unit of working and for that the area, so that in the year's coupe the restriction on yield is automatically waived. Its upkeep and future reproduction are also ensured.

The present working.

The application of the above change was brought into force immediately and efforts were made for the market to accommodate it. But it was realized that such a change could not work without an improved market or a change in the felling cycle or both if need be.

Up to 1935-36 the usual system of sales by auction of raw bamboos ex-forest depots was employed but remained unsuccessful and since the change, as also since 1927-28, nearly 3 lacs was the maximum number that could be sold in 1935-36; more than that the market could not accommodate. And therefore, only 1,658 acres could be properly worked from 1933-34 to 1935-36 yielding nearly 757,000 bamboos or 457 per acre. The reason was that the trade was in the hands of a handful of *Shaikhs* of Mukerian, Jullundur and Lahore who purchased our stocks as raw, manufactured them in accordance with the demand and acting as middlemen in their disposal had almost the monopoly over it. They were also responsible for the import of bamboos into the Punjab from sources outside the province from where they could make cheap credit purchases. To this selfish dealing there was no end and consequently at our sales auction combines were common. It was thus found

impossible to work the forests to their full capacity until the demand in the real market was re-established, because what appeared to be a dull market was actually due to the import of bamboos from outside the province, and if this could be checked there could be no difficulty in our gaining the original *status quo*. Consequently, in 1936-37 it was decided to establish personal contact with purchasers in the Punjab and N.W.F.P. and afford them facilities by offering them raw as well as fashioned bamboos of all kinds and sizes as it suited their purpose, ex-forest depots or ex-Mukerian. This was an impetus for every purchaser with whom contact was established, and there was no difficulty in effecting sales of 439,087 bamboos at the very outset. In order to avoid sudden overcrowding of the market, as a result of the inrush of bamboos from other usual sources through our middlemen in trade, this was considered sufficient as a start. The same course was repeated in 1937-38, selling this year 527,209 bamboos, so that by the end of this season no real market in the Punjab or N.W.F.P. was left void of bamboos from these forests in preference to those from elsewhere.

So much done led us to estimate the annual absorption of bamboos in the Punjab and N.W.F.P. market as varying from 5 to 6 lacs and therefore with the increase in output per acre it worked out to roughly a felling cycle of 4 years. This meant working of a comparatively small area annually but it ensured its thorough silvicultural working, at the same time compatible, with the market demand; and above all it ensured a safeguard against natural calamities such as a locust or hoppers' attack, hail storms, and deficient rainfall, etc: which could mar a year's growth. This also meant that at the time of fellings, bamboos that will be felled will vary in age from 4 to 6 years which is very good age limit for quality and is just before the deterioration starts. Coupe list was therefore prepared on this basis and work has since proceeded accordingly.

Other factors concerned with the upkeep and improvement of these forests as permanent amenities for the people are the control over exercise of rights and the artificial restocking of backward areas.

Excessive grazing is the master factor in this connection which is responsibe for loss of soil contents and recession of the water table

and, consequently, of the bamboo zone. It is however difficult, almost impossible, to interfere with the rights, but Government has allotted this business to the District Panchayat Officer recently, so that it may be possible to organize village societies on a co-operative basis to foster public interest by patience and tact in this behalf and it may ultimately be possible to:

(*i*) extend the 3 months closure to that of 4 months, *i.e.*, up to end of October. In lieu thereof free grass cutting can be allowed as an open right throughout the year.

(*ii*) discourage foreign Gaddi flocks who visit the village *shamilats* every winter so as to partly reduce the stress on these forests, and

(*iii*) restrict the number of cattle kept by the villagers to their minimum agricultural and domestic requirements by keeping better quality well fed rather than a useless quantity ill fed.

Meanwhile artificial restocking of backward areas by imposing small periodic closures is the only open course. Bamboo planting of nursery raised entire plants placed in pits dug 9″ × 9″ × 9″, with tops chopped up to height varying from 1′ to 1½′ and under the shade of bushes has been very successful. But 3-year-old seedlings when transferred have been found to ensure hundred per cent. success compared to 65 per cent. in case of 2-year-old seedlings, while one year old seedlings cannot stand the drought following the year of planting and die off. Of the 3,000 (approximately) planted in 1934, only 155 survived the hot weather. Care is taken in removing the plants from the nursery beds which are thoroughly saturated beforehand and the plants are carried with roots intact and soil around kept moist till actual planting. Spacement given varies from 6′ to 8′ in order to arrive at a final espacement of 12 to 16 feet. The work is carried out at the break of monsoons and if possible when it is actually drizzling. Of the important local hardwoods *Khair* (*Acacia catechu*), *Siris* (*Albizzia lebbek*) and *Rajain* (*Holoptelea integrifolia*) have been found to establish easily. Direct sowing of *khair* in 6″ raised patches, 1½′ × 1½′, dug up to 1′ below the sowing surface, have given excellent results as also planting of root and shoot cuttings of *Siris* and *Rajain*. Other species

B

have also been tried with varying results; direct sowings of all other species failed.

In this artificial work the general aim is to raise a mixed crop of hardwoods and bamboos which is a sure treatment against gregarious flowering, but it is necessary to be judicious in selecting the right place for the right species, *i.e.*, bamboos and hardwoods, and although both will prefer well-drained cooler localities bamboos have been found not to stand being planted in the open. It has been found by experience that under the prevalent conditions of excessive grazing, the grazing effects on the soil only gradually disappear so that artificial work in an area should commence at least a year and better 2 years, after the actual closure. The importance and value of these forests is also being increased by the introduction of superior quality bamboos, *viz.*, Nal (*Bambusa nutans*) and *Maggar* (*Bambusa arundinacea*) and it is hoped that these forests will ultimately form a valuable resource for mankind in the supply of bamboos, hardwood timber and firewood.

The forests are also being improved by laying out 2′ wide contour paths for purposes of inspection. These also facilitate the extraction of bamboos from forests to the forest depots. Eighteen miles of these paths have lately been built at a cost varying from Rs. 35/- to Rs. 40/- per mile.

(*To be continued*)

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GRASS AND TEAK PLANTATIONS

By S. A. A. Anvery

The difficulty of getting natural sal regeneration in the U.P. Forests was in no small measure responsible for favouring a teak planting programme in the Province. This introduction of a species not natural to the habitat is sometimes also justified by pointing out that, when mature, teak is about three times more valuable than sal and not half so expensive to plant and nurse up as the indigenous species. Our experience, short though it is, has however clearly shown to us that though one may not doubt the statement that, *when mature,* teak is much more profitable than sal, it is open to serious objection if teak will ever "mature" out of its habitat. Our experience in U.P. is that the planted teak generally starts well but begins to flower and fruit unusually early, and after that the vegetative growth is extremely slow if not actually non-existent. This happens when the plant is from 15 to 25 years of age and about 12 to 14 inches in diameter. This size of teak with an abundant white sapwood is practically valueless. It appears that the unusually early reproductive activities in the plant cause this slackness or even cessation of the vegetative activities. This relation between the two activities of a plant is a fairly well-established one. The extreme case is of bamboos which grow to big sizes for a number of years before they flower, and once they flower they die out. Physiologists have shown that different proportions of the essential food materials in the soil favour different activities in the life history of plants. It has been shown that a high proportion of nitrogenous matter in the soil results in increased woody growth in the plant and proportionately delayed and poor growth of fruits and flowers. An interesting example of this occurred in America. The late Prof. Hill-Guard was once advising woodmen as to the advantages of artificial nitrogenous fertilizers for better growth. A young, enthusiastic, farmer was also one of the audience. He determinedly went to his orange orchards and applied the nitrogenous fertilizer to them. Next season he found unusually healthy and vigorous growth of the orange trees but an extremly poor orange crop!

Let us go a step further. It has been shown that the dense growth of grass retards the growth of trees. It is not always because

of lack of moisture and root competition. It has been found that grasses use up proportionately a very high percentage of nitrogenous matter of the soil. Some plants are not very exacting and grow normally for some years to begin with. But the continuous leaching out of the nitrogenous matter of the soil by the grasses all around soon brings the soil to a stage when its nitrogenous contents are not enough for the increased vegetative activities of a good sized vigorous pole, with the result that such activities are greatly retarded or even arrested and the pole starts to flower and fruit prematurely or even dies in some cases. This is perhaps why the Kent orchard farmers in England definitely favour a grass cover under their fruit trees because, they say, it keeps the timber growth arrested within bounds and increases the fruit crop. Dr. Burtt-Davy observed more or less the same phenomenon with the cricket-bat willow.

With this fact taken as more or less established let us now again revert to our teak in U.P. One of the reasons in favour of introducing teak planting in U.P. was that it was very inexpensive to plant and that it did not demand much attention and care later on. It was neither grazed nor browsed and it was shown that even cleaning and grass cutting was not necessary, as it soon shot up and overtopped grasses. Most of the teak plantations are made with this idea, with the result which we have set out in the opening paragraph. It is perhaps pertinent to suggest that the unchecked grass growth in the teak plantations is perhaps partly responsible for its premature flowering and fruiting.

XI SIGMA PI

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True to tradition, University education in the United States of America, includes a more or less unique system of fraternities for boys and sororities for girls. These are national in size and may be purely social, or, in a way, technical. One such is Xi Sigma Pi

forestry honour fraternity, founded at the University of Washington in 1908, "to secure and maintain a high standard of scholarship in Forest education, to work for the upbuilding of the profession of forestry, and to promote fraternal relations among earnest workers engaged in forest activities." The fraternity has at present 10 chapters in 10 Universities in the United States of America and 3 are to be installed in the current year. (The chapters are alpha, beta, gamma, delta, epsilon, zeta, eta, theta, iota, kappa, lambda mu & nu). The whole business is Greek to us.

The intention of Xi Sigma Pi is "to honour the student who is doing good work in forestry and who has a personality that would tend to make him successful in forestry work. The fraternity aims at stimulating scholarship in forestry and at bringing together in good fellowship, those students who have shown exceptional ability. The establishment of chapters at various universities and colleges throughout the United States has resulted in linking together earnest students from various parts of the country with a common interest. At the present time the fraternity has 333 active members, 1,355 alimni members, 54 associate members, and 3 honorary members.

The fraternity is governed by an elected executive council, and consists of active, associate and honorary members. Conventions are held biennially and office bearers re-elected. The badge of the fraternity is a key or pin, beautifully mounted in gold. Girls show off with pride the keys and pins of their boy-friends, during occasions of celebration.

The initiation to the fraternity is a very serio-comic affair, the initiates having to undergo examination *viva-voce,* tests of tree climbing, cooking and other similar activities, and an oath, secretly administered. Fines and penalties of an amusing nature are ordered on the initiates. Thus an initiate was asked to turn the hose pipe on the first person that entered Anderson Hall, (College of Forestry building in the University of Washington), and face the consequences!

India has any number of eminent Foresters in its service personnel, and a fraternity similar to the Xi Sigma Pi may very well be provided to bring together in spirit the scattered forces. This suggestion is sufficient apology for this short note.

THE RÔLE OF CHEMISTRY IN FORESTRY

PART III

BY DR. S. KRISHNA

Presidential Address at the Twenty-seventh Indian Science Congress

The rôle that Chemistry plays in the utilization of the M.F.P. is undoubtedly large. For proper utilization the chemist has to concern himself with problems such as the best and the most economical method of extraction of the active principles, the study of the chemistry and constitution of the constituents, questions of drying and storage and many other related problems. All these have an important bearing on the proper utilization of raw materials and the following account has been written with that view-point.

From the revenue point of view, bamboos and grasses are next in importance to timber. Ever since it has been found possible to convert them into pulp, both of these have entered the industrial field and their utilization as raw material for paper pulp has helped to render India partially self-sufficient with regard to paper, a prime necessity of civilized life. Grasses yielding more readily to chemical treatment were the first to be converted in this manner. The paper industry up till 1930, used sabai grass (*Pollinidium angustifolium*), common in Northern and Central India and this was the staple raw material. Other grasses like ulla (*Anthistiria gigantea*), munj (*Saccharum munja*) and Kans (*Saccharum spontaneum*), although not as good as sabai for the manufacture of writing paper, are promising raw materials for a variety of other kinds of paper. But with the growth of paper industry it had soon been realized that grasses alone could not meet the ever growing demand, and a search for other possible raw materials resulted in the selection of bamboo, mainly on account of its plentiful supply. Bamboos, with all their knots, presented a knotty problem to the chemist and taxed all his ingenuity to convert them economically into paper pulp. In 1925, the problem was solved and its suitability for manufacture of a variety of writing and printing paper has since been fully demonstrated. With the introduction of bamboo pulp and the protection given by

the Government, the paper industry has made reasonably rapid progress. In 1924-25 the total production of paper by the Indian mills was 27,000 tons which in 1938-39 has risen to nearly 59,198 tons of which bamboo pulp contributed 27,000 tons.[16] Bamboos and grasses, though satisfactory for producing medium and superior quality paper are uneconomical for the production of cheaper grades of news-prints, paper boards, wrapping paper, etc., all of which contain a high percentage of mechanical pulp. Therefore, for production of cheaper quality paper, possibilities of producing mechanical pulp from soft woods like fir and spruce, which are plentifully available are being investigated. Should these attempts prove successful, India will be completely independent of foreign imports of paper.

Turpentine from the oleoresin of *Pinus longifolia* has been distilled in Northern India for nearly half a century and for many years the producers were unable to detect the reasons for the inferior quality of the Indian turpentine, which left a sticky residue on drying, even when the latest methods were employed in its distillation. It was only when a systematic chemical study was made that it was discovered that the presence of Δ^3 Carene and a slow drying sesquiterpene were the constituents of Indian turpentine which imparted to it the undesirable quality. Rectification of the bulk oil was the obvious solution and to-day India produces turpentine of a quality comparable with the French and American products. The importance of such an investigation can be realized from the fact that the two distillaries at Jallo (Lahore) and Bareilly together distilled in 1937-38, 135,000 mds. of resin, from the Punjab and U.P. forests, yielding a revenue of over 6 lakhs.[17] At present, only a fraction of the *Pinus longifolia* (chir) forests, occurring in the lower and easily accessible areas are being tapped and those of the higher regions are left unworked. *Pinus longifolia* is not the only turpentine yielding pine in India. *Pinus excelsa, P. Khasya, P. Gerardiana* and *P. merkusii* have all been shown to yield turpentine of very high quality containing 80 per cent. of A and β pinene.[18] This result is of immense value to a camphor importing country like India since pinene is the starting raw material for the manufacture of synthetic camphor. The importance of this may be judged from the fact that India during the past 15 years has been importing camphor to the value of about Rs. 23 lakhs a year. All this, and

much more could be manufactured in the country if only, with a little enterprise, pines from those areas are tapped which have, hitherto, been labelled as inaccessible. Prof. Simonsen of the Bangor University (N. Wales) and formerly of the Forest Research Institute, Dehra Dun, remarked in a recent address to the Institute du Pin that "India can meet not only her own requirements of turpentine but can supply the demand of the whole world."

The import of camphor into India is likely to increase with the further growth of the camphor consuming industries and it is, therefore, necessary to search all possible sources of camphor, both natural and synthetic. A fruitful line of research would perhaps be the examination of *Basilicum spp.* of India. According to an announcement[19] 18–20 tons of camphor are said to have been produced in Russia from an African species of *Basilicum*, cultivated in South Ukraine and Crimea. The camphor tree (*Cinnamomum camphora*) grows and, in fact, has established itself in Southern India, and it has been shown that the oil from the leaves yields camphor in workable quantities[20] but the question of raising plantations, at an economic cost, is still a debatable matter. It is perhaps not always easy to explain the difficulties that are attendant upon economically successful working of a chemical industry, even when the raw material is available in plenty. This point may perhaps be made more clear by taking the case of thymol, which is an important antiseptic and anthelmintic. It is obtained in India from ajowan seeds (*Carum copticum*, a plant which grows extensively in Indore, Hyderabad and other places). During the war period, a distillation factory was started in Dehra Dun but after a run of several years had to close down due to a variety of causes. One of the possible causes for its failure was the quality and the price of the raw material which raised the cost of production. Also, on account of competition with the synthetic thymol, from Germany, production in India became unremunerative. Ajowan seed is not the only natural product, in India, that is a source of thymol. The oil of *Andropogon Jwarancusa*, a grass growing wild in Hazara and Sind, is another source. This oil contains 70 per cent. of piperitone, a constituent which on oxidation yields thymol.[21] Australian eucalyptus oil, containing 50 per cent. of piperitone is being employed for the purpose but, in India, this source has not been tapped at all. Yet another source lies in the

cumin oil, from *Cuminum cyminum* which is cultivated extensively all over the country. At present cumin is used as a spice and over 4 lakhs worth were exported in 1936-37. To make an economic success of the thymol industry, all its possible sources will have to be thoroughly scrutinized and the methods of cultivation very carefully looked into. The cultivation of such economic products is at present done in a very half-hearted way and the farmer feels quite satisfied if he obtains a reasonably good crop of seeds, irrespective of their oil content. Since no collaboration between a cultivator and a chemist exists, it is not possible to help and advise him about the choice of land, seeds or manures, with the result that products of poor quality are placed on the market, and to work up such products becomes wholly unremunerative. The Indian ajowan seed yields about 3 per cent of oil containing about 25 per cent. of thymol and these very seeds under scientific cultivation in Seychelles have given 9 per cent. of the oil with over 40 per cent. of thymol.[22] How very difficult, therefore, it is for the Indian industrialists to produce the product at competitive prices. The case of Ajowan seed is not the only one where a possible industry has been choked through neglect in cultivation. Another instance is that of vetiver oil from the roots of *Vetiveria zizanoides* popularly known as Khas. This grass grows wild in most parts of India near the river banks, ponds or marshy places and in many places it is cultivated, the chief centres being Rajputana, (Bharatpur), Chota Nagpur and Travancore. The oil obtained is highly prized by local perfumers and the history of its distillation, in this country, goes back into antiquity, but no attempts appear to have been made to improve the yield or the quality of the oil. Java has taken seriously to its cultivation and has been able to produce grass which contains as much as 4 per cent. of oil, compared to the Indian grass which contains at the most only 1 per cent.[23] Java has already started exporting this oil into India and unless suitable steps are taken, even the existing local distillaries and with it this ancient industry will be wiped out. Java in 1937 exported nearly 45,000 lbs. of this oil valued at £45,000.

Rosha or Palmrosa oil, from the grass *Cymbopogon martini* is another essential oil of commercial importance of which India is the biggest exporter. This grass grows wild in the Central Provinces and Bombay Presidency, where it is distilled by comparatively crude

processes, often imparting a burnt odour to the oil. The producers have never bothered to adopt the suggestion for improvement mainly because the Indian oil has a consistent demand, which is due to its high (90—94 per cent.) content of geraniol, an important constituent of many synthetic perfumes. The export in 1937-38 was 10,837 gals. valued at Rs. 4.13 lakhs and India, almost holds the monopoly and, therefore, there is the greater reason that this product should be improved in quality and quantity. A demonstration of what can be done in this direction, by application of scientific methods, is given by a small plantation of *Cymbopogan* grass in Lyallpur (Punjab),[24] where 3,000 lbs. of high quality oil is produced, which always finds a ready sale, at a premium. The above remarks apply equally to the lemongrass oil from *Cymbopogon flexuosus* and C. coloratus. India exported 90,121 gals. valued at Rs. 7.23 lakhs in 1937-38.

The sandal wood oil is perhaps the only essential oil that is being scientifically worked up in India and it is purely by virtue of its quality that it is able to hold its own in the perfumery markets of the world, in spite of the serious competition from similar oils of Australian and African origin. Mysore sandal oil holds a high reputation and fetches a higher price than its competitors. India exported 15,185 gals. of it valued at Rs. 14.12 lakhs in 1936-37 and by establishing this industry Mysore has earned considerable benefit. Large quantities of sandal wood are still being exported from other producing centres and it seems a pity that for want of sufficient enterprise the entire output of wood is not being distilled in India for its oil.

Raw materials for production of essential oils, in India, are available in large quantities (21 lakhs worth of essential oil seeds were exported in 1936-37), and this can be further increased by proper organization and cultivation. Excepting for the oils mentioned above, the essential oil industry is practically non-existent in India and in this direction, India can very well take a lesson from Java. By making use of scientific results in cultivation and distillation, Java, a small island compared to the continent of India, has been able to build up an important position for herself, in the essential oil markets of the world, and her export trade meets nearly 25 per cent of the world demand.

Large numbers of oil-bearing seeds are available in our forests, which yield fats and oils, suitable for a variety of purposes. Of these some have been commercialized: kusum (*Schleichera trijuga*), mahua (*Bassia spp.*), pongam (*Pongamia glabra*), margosa (*Azadirachta indica*), malkangni (*Celastrus paniculata*), chaulmoogra (*Taraktogenos kurzii* and *Hydnocarpus wightiana*), but there are many more which have remained unexploited. Piney tallow (*Vateria indica*), Chinese tallow (*Sapium sebiferum*), kokum butter (*Garcinia spp.*), sal butter (*Shorea robusta*), for example, have not attracted as much attention from the trade as they deserve even though they have all been shown to be admirably suited for making size paste, soap, candles, leather dressing, axle grease, etc. In fact, they possess the same properties as tallow and can easily replace it for the above purposes. Extended use of these vegetable tallows would, therefore, help to stop the import of tallow which in 1936-37 cost over 35 lakhs of rupees. Another important group of fats that hold out promise of industrial application are the fats from the berries of *Actinodaphne* and *Litsea* species belonging to the *Lauraceæ* family. This family is widely distributed throughout the country and about 50 species are known to occur in Indian forests. The value of fats from these trees depends upon their richness in the glyceride of lauric acid, which is the basic substance for a newer type of detergent useful alike in soft, hard or saline water. Apart from its use as a detergent, lauric acid has a considerable demand on account of its industrial application in the manufacture of a variety of products. Consequently, a survey of the quantity of seeds of *Lauraceæ* family available in forests and the question of putting up plantations is being seriously considered. Careful and well-planned schemes for the utilization of these forest products would prove of great economic value both to the producer as well as to the consumer.

Other important minor products that add their quota to the forest revenue, are the tanning materials. Forests supply a variety of tanning materials to the leather industry, the most important of these being myrobalan, of which the export trade alone runs to over Rs. 37 lakhs a year. (A good proportion of this comes from outside the Government forests.) The others are babul bark (*Acacia arabica*), avaram (*Cassia auriculata*), amaltas (*Cassia fistula*), mangrove (*Rizophora sp.*), cutch (*Acacia catechu*) and a few more, all of which are utilized by the tanners in India. Establishment of the different tanning centres in India has been the direct outcome of the quality and plentiful availability of some of these tanning materials. Babul bark and pods, for instance, support the leather industry at Cawnpore and cassia bark, the half-tanned hide industry in Madras. The demand for tanning materials is increasing every day and this is

not surprising, considering that India produces 25 million cow and buffalo hides annually.[25] During the last few years "tanners in Cawnpore have been faced with increasing scarcity of babul bark. This scarcity is principally due to the increase in number of tanneries and absence of any organized plan for replanting trees which are cut down every year for commercial timber, firewood and manufacture of charcoal."[26] Some well-planned action to maintain the level of supply is, therefore, urgently needed. In spite of the large quantities of tanning material being available in India the total requirements of the country are not being fully met, since nearly Rs. 15 lakhs worth of tanning material has to be imported annually. Attempts, however, are being made to cultivate the required varieties of tanning materials to make the country self-sufficient. The Madras Forest Department has planned to start cassia and wattle plantation.[27] Along with tanning materials, mention may be made of the vegetable dyes. In these days of synthetic dyes it may be a matter of surprise to some to know that a small trade, both internal and external, still exists in these natural dyes. The more important of these are turmeric, cutch, lac dye, indigo, kamala, etc. Mention may also be made of gums and resins such as colophony, dammar, boswellia gum, gugal (*Balsamodendron mukul*), asafœtida (*Ferula fœtida*), gurjan (*Dipterocarpus spp.*), thitsi (*Melanorrhœa usitata*) and others. Large quantities of these find application in local industries and in addition Rs. 27 lakhs worth are exported.

(*To be continued.*)

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EXTRACTS

THE WESTERN ISLES THROUGH THE MISTS OF AGES

By Sir Albert C. Seward, F.R.S., President of the British Association*

Introductory.—Twenty-seven years ago, when the British Association met for the second time in Dundee, Sir Edward Schäfer chose as the subject of his presidential address, "The Nature, Origin, and Maintenance of Life;" he discussed problems that will long continue to exercise the ingenuity and stimulate the imagination of biologists and chemists. A theme such as his is far beyond my reach. Seventy-two years ago, the Association met for the first time in this city. The Duke of Buccleuch occupied the presidential chair, and the opening words of his address are applicable to one who now finds himself in this privileged position. The Duke said: "No man has a title to state that he is unworthy of the post he is called on to fill, whatever may be his private feelings as to his fitness for the post. To state that he is unworthy to be there placed is not only a disparagement to himself, but is no great compliment to those who thought him worthy of being so placed."

This, in my opinion, is not an occasion on which it is desirable to follow the easier course and address oneself in technical language to fellow-workers in the pursuit of natural knowledge. The position which it is my great privilege to occupy affords a rare opportunity of talking to a large and, I venture to hope, a sympathetic audience, including some at least who are repelled by the jargon of specialists. My intention is to speak in ordinary language on a subject of which I know enough to realise how little that knowledge is, and briefly to describe an example of the way in which, within one small patch of an illimitable field, a student asks questions of Nature and does his best to interpret the answers.

An Excursion into the Past.—I invite my audience to accompany me on an excursion of a kind which has substantially contributed to the enjoyment and enrichment of my own life, an excursion into a world that knew not man, with the object of deciphering

* Presidential address delivered at Dundee on August 30.

from such records as we find in the rocks a few pages of the story-book of the earth. Each one of us can say with Shakespeare's soothsayer:

"In Nature's infinite book of secrecy
A little I can read."

As that great Scotsman, Hugh Miller, wrote nearly a century ago: "We find the present incomplete without the past—the recent without the extinct." To reinforce his own opinion he quoted Samuel Johnson: "Whatever makes the past, the distant, or the future predominate over the present advances us in the dignity of thinking beings." We shall try to reconstruct a small part of an ancient land, a remnant of which is now called Scotland, and envisage a scene at a stage in the history of the earth separated from the present by at least sixty million years, a stretch of time difficult for us who have been called "the afterthoughts of creation" fully to appreciate. When we substitute geological standards for the modest time-scale of the human period and remember that the earliest chapters of the world's history are recorded in rocks at least two thousand million years old, sixty million years dwindle to comparative insignificance. All that it is possible to do is to lift a corner of the veil separating us from the world as it was and view through dimly illuminated vistas the forests and undergrowth on an ancient continent that is now represented by a few widely scattered, dismembered pieces.

The History of Plant Life.—The history of plant life in the sea and on land is a branch of natural knowledge not unworthy of consideration by us human beings who owe our existence to the vegetable kingdom. Green plants in one vital sense are our superiors: from air and water they build up the complex organic substances necessary to our life, a feat beyond man's power. As members of a subject race we should be interested in endeavouring to unravel the history of the plant kingdom—in trying to trace the origin and relations of the several classes and groups as defined by botanists. The documents that are the sources of the botanical historian are contained in the earth's crust: as a preliminary it is worth while to ask ourselves of what these documents consist; how they came to be preserved in the rocks.

In order to bring to life the past we must take the present for our guide: "speak to the earth, and it shall teach thee." There is

no reason to think of Nature's methods as other than continuous. If we stand by the bank of a river flowing past tree-covered slopes, we see on the sand and mud by the edge of the channel or floating on the stream, leaves, twigs, and seeds that are random samples of vegetation scattered by wind or shed from overhanging boughs, debris swept along with off-scourings from the rocks to be carried eventually to a delta or an estuary where the waterborne material comes to rest. Beds of old sand and mud, with included fragments of contemporary trees and other plants, exposed on the faces of cliffs and ravines, are layers of sediment that have been raised to a higher level. In addition to leaves, twigs and other scraps easy to see on the split surface of sandstone or shale, sediments of former ages, especially such as are peaty, occasionally furnish another valuable source of information invisible to the unaided eye. Minute grains of pollen may be carried by wind to places where conditions are favourable for their preservation: fortunately the grains, or at least most of them, are protected by highly resistant coats and retain almost for all time their characteristic form and surface-sculpturing. With scarcely any exception, it is possible for a specialist, by comparative microscopic examination of fresh material, to assign fossil pollen-grains to their generic and occasionally their specific position in the plant kingdom.

There is another natural agency to which students of extinct plants are not infrequently indebted—the formation of rocks by volcanic action. From time to time, volcanoes that have long been dormant eject clouds of ash; these, with streams of lava poured over the rim of a crater, spread havoc among trees and shrubs that had colonised precarious sites during a peaceful interlude. Vulcanicity is not only destructive: paradoxical as it may seem, forces inimical to life have contributed to the reconstruction of life which they destroyed. Scotland is exceptionally rich in botanical treasures that are legacies from ages of fire, and indeed the fossil plants with which we are concerned here owe their preservation to volcanic forces.

The following botanical retrospect is based mainly on results obtained during the last two or three years, but not yet published, by the joint efforts of Mr. W. N. Edwards, keeper of geology in the British Museum, Dr. J. B. Simpson of the Geological Survey, and myself.

RECONSTRUCTION OF A FOREST SCENE

A.—THE GEOLOGICAL BACKGROUND

(*i*) *Prolonged and Intermittent Volcanic Activity.*—In order to present in true perspective the scene which it is my aim to bring to life, it will be helpful to visualise the physical features in north-western Europe some thousands of years antecedent to the phase of geological history chosen for closer examination. The chalk downs of England and part of the cliffs on the Antrim coast of Ireland are made of upraised calcareous material that was once a soft white ooze on the floor of a clear sea, a sea which had swept slowly and irresistibly over an enormous stretch of land, embracing the greater part of England, northern Ireland and part of the region that is now western Scotland. With the uplifting of the chalky ooze from the ocean bed and the gradual recession of the waters a new land was born; a new chapter was inaugurated in the history of the earth.

Following the great upheaval, as a consequential phenomenon, subterranean forces that had long been quiescent gained the upper hand: floods of semi-molten rock from deeply hidden reservoirs surged as a fiery deluge over the chalk downs and over other and older rocks, converting thousands of square miles into barren lava-fields, extending over an area not less than 2,000 miles from south to north which reached far beyond the Arctic Circle.

This unprecedented manifestation of volcanic energy, which is by no means confined to Europe and the arctic regions, but recorded on an equally titanic scale in the peninsula of India and elsewhere, is one of the wonders of geology; it is convincing evidence that the earth, after the lapse of many hundred million years, had not lost her youth; there was no sign of senescence. During the period we are considering, most of Britain was land: we know that at a slightly later date a broad sea lay over the whole of what is now southern England. Travellers in the tube-railway in the London district may perhaps derive pleasure from the knowledge that they are being conveyed through a stiff clay upraised from the floor of that ancient sea. As an appropriate designation for the great northern land an American geologist suggested the name Thulean Continent or province. In the early days of the period called by geologists the Tertiary era, the greater part of the Thulean province was

covered with sheets of sombre-coloured lava in nearly horizontal layers, products of a series of outbursts from deep fissures rent in the earth's crust under the compelling strain of subterranean forces, and from localised volcanic centres of eruption. The columnar basalts of the Giant's causeway, the columns of the "Cathedral of the Sea" at Fingal's Cave, the basalts of Mull, Skye, Canna, Eigg and other Western isles, weathered into step-like terraces, which form a characteristic feature of Hebridean cliffs, the flat-topped McLeod's Tables of Skye (1,600 feet), precisely similar basaltic platforms on the hills of Disko Island and the mainland of western and eastern Greenland—all these are parts of one stupendous whole, a plateau covering half a million square miles, that was once the Thulean Continent. The wide-spread lava-flows represent one phase of volcanic activity in an age of exceptional unrest.

Another phase is illustrated by more coarsely crystalline rocks such as those of the dark Cuillin hills of Skye: they were not poured out as lava-streams over the land, but were forced upwards as great dome-like masses from a deeply seated subterranean source and, as their coarser texture proves, slowly cooled under the pressure of a thick superincumbent load: the comparatively large size of the crystals indicates gradual solidification from a molten mass.

These two phases of prolonged rock-building help us to appreciate the immensity of geological time. Describing the lava-flows of Mull, Sir Archibald Geikie wrote: "On Ben More we can walk over each bed of basalt from the sea-level to the mountain top, a height of 3,169 feet." The basaltic lavas we see in the cliffs of Mull, and many other islands are but a part of the original pile: those that remain furnish an impressive example of rock construction which must have extended over an enormous period of time. The second phase, on the other hand, is an equally impressive example of rock destruction as a measure of geological time. We see the jagged peaks of mountains rising to a height of 3,000 feet above sea-level which, at no distant date as earth history is reckoned, were buried under a considerable thickness of younger rocks that have been utterly destroyed by the ceaseless operation of denuding agents.

The world to our limited vision appears to be almost static; the mountains we have been accustomed to think of as symbols of

eternity, seen through geological spectacles, take their place as episodes in a series of events which have moulded the changing features of the earth's face. The rocky covering of the world viewed by geologists, "foreshortened in the tract of time," reveals itself as a dynamic, mobile crust responding from age to age to constructive and destructive forces which have operated since the earth's early youth, following a still earlier stage when, in the imagery of the poet,

"This world was once a fluid haze of light."

(ii) *Plant-bearing Sediments indicative of Quiescent Intervals.*—So far the events chronicled in rocks of igneous origin have been spoken of as though there had been continuous outpourings of lava with occasional showers of ash and, in some districts, upwelling of molten material that remained hidden below the surface until in the course of time the covering rocks were removed by erosion. There is, however, clear proof that the extrusion of lava and other rocks was intermittent: intercalated among the lava-beds are the layers of sedimentary material, hardened sand and mud, layers of coal and beds of fine-grained limestone containing beautifully preserved leaves, a few fruits and other plant fragments, also rare examples of insect wings and shells. The richest plant-containing layers occur near the base of the pile of basaltic lavas on Ardtun Head, the low "headland of the waves" near the south-western corner of Mull, the island on which from his home on Iona—which has been aptly named "the light of the western world"—Saint Columba must often have gazed. Trees, shrubs and other plants were able to colonise portions of the lava-field during the long pauses between recurrent outbursts of volcanic fires.

The association of sedimentary material with the basalts at Ardtun Head was noticed by Abraham Mills so long ago as 1790: but it was not until the middle of the nineteenth century that Mr. McQuarrie of Bunessan discovered the fossil plants, which were very briefly described by Professor Edward Forbes in an appendix to an important paper by the Duke of Argyll published by the Geological Society of London in 1851. The Duke spoke of the leaves as having been shed "autumn after autumn into the smooth still waters of some shallow lake, on whose muddy bottom they were accumulated, one above the other, fully expanded and at perfect rest." By far the richest collection of fossil was made by Mr. Starkie Gardner rather

more than fifty years ago, and partially described by him in a paper read to the Geological Society in London in 1887. Descriptions of several fossil plants from the Mull beds have also been published by Dr. T. Johnson. The main collection is now in the British Museum. Additional specimens have been obtained by other collectors in more recent years.

The work of deciphering the botanical records from Mull, Skye, and a few of the other islands is rendered mildly exciting by the danger of misinterpretation: fossil leaves, we are often reminded, are very uncertain guides—records left by Nature in a mischievous mood to mislead the unwary and overconfident student. Sir Joseph Hooker, in an address to the British Association at Norwich in 1868, spoke of fossil botany as "this most unreliable of sciences;" but he added by way of consolation—"the science has of late made sure and steady progress, and developed really grand results." One may cheerfully take the risk of being called an unscientific optimist by colleagues whose chief concern is with living plants. Botanists who confine their attention to recent plants have ample sources of information, not merely detached leaves but twigs bearing leaves, flowers and fruits: it is natural, therefore, that they should tend to under-estimate the value of leaf-form and venation, often the only criteria available to the palaeobotanist.

B.—THE ANCIENT FLORA OF THE INNER HEBRIDES

What then is it possible to say about the ancient flora of the Inner Hebrides without transgressing the limits of probability? We know very little of the smaller and simpler plants which lived under the shade of the forest trees or clung to the surface of stems where they were washed by trickling rills of rain-water. The three smallest plants which have left recognisable fragments are a fungus and two liverworts or, as they are often called, hepatics, a group allied to the mosses but of simpler construction. The fungus was found by Mr. Edwards several years ago on some detached leaves of a conifer from the Mull plant-beds; the manner of its discovery illustrates an interesting technique often employed with success by students of fossil plants. In many instances leaves preserved on shale are covered with very thin, black coaly film produced as the result of chemical change in the plant tissues after death. It is often possible, by

detaching a piece of the film and treating it with certain clearing agents, to remove the carbonaceous matter and obtain a sample of the surface skin of the leaf that is brown in colour, transparent, and suitable for microscopic examination. After treatment, the Mull leaves showed some minute dark spots on the surface film and these on magnification were found to be circular disks made of rows of radially disposed cells. The disks were identified as organs of a fungus closely resembling reproductive structure of a living genus *Phragmothyrium*, a fungus now mainly tropical; the occurrence in Mull of a nearly allied form is, however, probably indicative of a moist rather than a tropical climate. One of the liverworts bears a close resemblance to a living species, *Pellia epiphylla*, which has a wide geographical distribution and is very common on damp earth in Britain; it has a flat, green, forked body barely an inch in length.

The other hepatic is a member of a different family, characterised by a slender thread-like stem bearing two rows of minute leaves; it bears a striking resemblance to some living species included in the order *Jungermanniales*.

These fragmentary remains of liverworts are worth mentioning because fossil examples of such plants are comparatively rare; also for a more important reason. A few years ago Professor J. Walton of Glasgow published a description of some liverworts discovered for the first time in rocks containing remains of plants which grew in the forests of the Coal Age about 200 million years ago. The interesting fact is this: the Palaeozoic liverworts differ scarcely at all in the construction of the delicate plant-body from the much later forms from the Thulean Continent: both are essentially modern and yet both are surprisingly ancient. We do not know much about the history of these plants, but it is clear that some liverworts persisted through a succession of geological periods with practically no modification of their simple design.

The only fern so far discovered is very nearly related to the sensitive fern, *Onoclea sensibilis*, a familiar species in North America, ranging from Florida to Newfoundland and as far west as Saskatchewan; it occurs also in Northern China, Manchuria, Japan, and Corea: it has what is called a discontinuous geographical distribution. *Onoclea*, no longer a native of Europe, is often cultivated. The fossil fronds from Mull, both sterile and fertile, differ scarcely

at all from those of the living fern. Records of the rocks show that *Onoclea* formerly grew in north-western Europe and in Greenland, regions where, through the vicissitudes of climate, it long ago failed to survive. Evidence furnished by fossils and the facts of geological history affords a clue to the present discontinuous range: in all probability *Onoclea* originated on the Thulean Continent, perhaps north of the Arctic Circle, whence it spread radially into America, Europe, and the Far East; in the European region it became extinct, sharing the fate of many other plants that were unable to survive the rigours of the Ice Age. Its territory was originally continuous; now it is restricted to North America and Eastern Asia. Another member of the class to which the ferns belong is the familiar *Equisetum*, the horsetails: one species, closely comparable with the living *Equisetum limosum*—widely distributed in north temperate and arctic lands—has been found in the sediments of Ardtun Head. Equisetum may be described as an emblem of changefulness: nearly related forms grew in Palaeozoic forests at least 150 or 200 million years ago: less closely related plants in the same forests—the calamites—were comparable in size with trees. The slender horsetails of the Coal Age and their much more robust and woody allies remind us that in the course of evolution some of Nature's early experiments survived unaffected by the production of new competitors, while others, less successful, left no direct descendants. As we follow the march of plant-life through the ages, evidence of progress accompanied by retrogression becomes recurrently apparent: in the varying green mantle of the earth there can be traced threads running through the whole, changing very slightly as we follow them onwards and upwards, preserving all the time a remarkable uniformity in essential characters.

By far the greater number of the fossils from Ardtun are leaves of trees or shrubs which belong to one or other of the two great classes of seed-bearing plants. In *Gymnosperms*, including conifers and some other less familiar plants, the seeds are naked. In members of the other class, the highest, the most various and most abundant in the vegetable kingdom, the seeds are more efficiently protected and are contained in a closed case; hence the name *Angiosperms*. Conifers played a prominent part in the Hebridean forests, but their representatives were not such as we find in modern Europe.

A single and well-preserved seed attached to a relatively large wing affords evidence of the occurrence of a conifer allied to the silver fir (*Abies pectinata*) and some other species commonly cultivated in Britain. Firs, using the term for trees belonging to the genus *Abies*, and excluding the spruce fir (*Picea*), now occur in Europe, northern Africa, northern Asia and America: there is no British species of Abies. The Mull seed, it is important to note, agrees most closely with seeds of firs now living in China and Japan. Among other conifers discovered in plant-beds of Mull and Skye are *Cephalotaxus*, *Cryptomeria* and *Sequoia*. Recent species of *Cephalotaxus* are comparatively small trees confined to the Far East; some kinds are cultivated in our gardens. The foliage of the Mull species bears a striking resemblance to that of *Cephalotaxus fortunei*, a small tree widely distributed in China. Another genus which we believe to have been a member of the Hebridean flora is *Cryptomeria*: the fossils from northern Ireland and the Isle of Skye include foliage shoots, cones and pollen-grains. The solitary living species is the Japanese *Cryptomeria japonica*, which occurs also in China: this is the tree of the famous avenue of Nikko in Japan, a noble memorial of a peasant who was too poor in worldly goods to contribute the usual building stone or a bronze lamp to the mortuary temple of an emperor, and instead offered to plant trees to protect visitors against the heat of the sun.

One of the most interesting of all living conifers is the genus *Sequoia*, of which there are two species confined within the narrow strip of hill ranges bordering Oregon and California on the Pacific Coast—the redwoods (*Sequoia sempervirens*) of the Coast Range, watered in the dry seasons by the mists from the western ocean, and the mammoth trees (*Sequoia gigantea*, often called Wellingtonia) of the Sierra Nevada. *Sequoia* is an impressive example of the light thrown by fossil plants on the past history and wanderings over broad regions of the earth's surface of trees that, without man's protection, would be in danger of extinction. In earlier periods *Sequoia* was almost cosmopolitan; it ranged over wide spaces in the Old and the New World and overstepped the limits of the northern hemisphere. Foliage shoots preserved in the sediments of Mull were in all probability borne by trees closely related to the living redwoods, trees which are well worthy of inclusion among the wonders of the

world; they attain a height of more than 300 feet and the rings on cross-sections of giant trunks that have been felled bear witness to an age of 3,000 years or more. They were growing where they stand to-day 1,000 years before the Christian era. Trees next of kin to the redwoods once lived within a short distance from the Polar Sea several hundreds miles farther north than the present tree-limit. Another species of *Sequoia,* more nearly allied to the mammoth tree, lingered on in Britain long after the disappearance of the Thulean forests: this we know from the discovery of fossil twigs and cones in the sediments of an old lake on the edge of Dartmoor in Devonshire. The two surviving species live in splendid isolation, dreaming of a greater glory that was theirs, their memories stored with secrets man can never know. There was another naked-seeded tree in the forests into which we have intruded, a species of Ginkgo, the maidenhair tree. The barbarous name "Ginkgo," invented in 1712 by the German naturalist Kaempfer, is in the opinion of the Rev. Dr. Moule, formerly Professor of Chinese at Cambridge, a false transcription of "sankyo," which probably means hill-apricot. Leaves perfect in form and venation were found in the chalky sediment of a lake that filled a hollow in the Hebridean lava-field; they differ from the foliage of the living tree only in a few minor features detected by the practised eyes of Dr. Florin of Stockholm in the microscopical structure of the superficial cells. Dr. Simpson discovered Ginkgo pollen-grains at another locality. The story of the maidenhair tree has recently been told (*Science Progress,* January, 1938), and the temptation to linger over it here must be resisted.

Ginkgo, of all trees, furnishes the most thrilling example of a link with the past; its history, compiled from fossils of many geological ages and in many parts of the world, is an enthralling romance. This is but one of many histories recorded in Nature's story-book which makes us share the thought of Edward Fitzgerald: "Yes, as I often think, it is not the poetical imagination but bare science that every day more and more unrolls a greater epic than the Illiad." It would be rash definitely to assert that the maidenhair tree still exists under strictly natural conditions as a wild tree of the forest. Botanists who have searched for it in China, the country believed to be its last home, failed to discover convincing evidence of the occurrence of specimens which could not be ascribed to man's agency. On the

other hand, a few years ago a Chinese expressed the opinion that Ginkgo still grows wild in the province of Chekiang in eastern China. The oldest living examples occur in China and Japan, often in places, as is fitting, where they are venerated as trees endowed with healing properties.

The history of Ginkgo has been traced to periods antedating by millions of years the Thulean forests: we do not know of what sort its progenitors were; but we know that it is a survival from an age too remote for us to measure in terms which we can fully appreciate. We also know that Ginkgo, now a lonely relic in the present world, is a primitive and isolated type, the sole representative of a large family, including many different members, all of which, save the maidenhair tree, long ago, fell by the way in the struggle for existence. When the tree lived in the Hebridean forests it was common in other parts of the Thulean Continent from northern Canada to Greenland and Spitsbergen, in North America, Europe and Asia. It was as widely distributed geographically as oaks, pines and firs in the modern world. The history of Ginkgo is a record of endurance, of persistence with apparently little change in an unstable world. When we recall the amazing life-story of the tree and its forbears the autumnal colour acquires a deeper significance: we see in the pale yellow of the leaves a reflection of the golden age of a family that left a precious legacy. Would that the maidenhair tree were endowed with the oracular power of the oaks of Dodona and, in the trembling accents of its fluttering leaves, could tell us not of the future but of the varying fortunes of the family as age succeeded age.

The Ginkgo of Mull was not the last of its race in Europe: well-preserved remains have been found in younger rocks in France and Germany, proving that it survived in the Western world, though probably only in a few places, to an age preceding by a comparatively short period the invasion of temperate Europe and North America by arctic ice-sheets and glaciers, which had a far-reaching effect upon the vegetation in the Western world.

Leaving the naked-seeded plants, we pass to the flowering plants or *Angiosperms*. This class is more recent in origin than the *Gymnosperms*—at least so it would seem—and as in present-day floras so also in the Thulean forests, flowering plants contributed the greatest number of genera and species. We shall take first a few trees and

shrubs which have descendants still living in Europe, and afterwards mention others that have no near relations in European floras. There were, we think, three or four kinds of oak, all different from those now living in Europe and America. The largest leaves from Mull assigned to the genus Quercus are oval, with a broadly rounded base and relatively small teeth; they resemble the foliage of a few Indian species, but the oak, with leaves most closely resembling the fossil form, is *Quercus serrata,* a native of China, the rain-forests of Assam, Japan, Korea and the Himalayas. A second species from Mull is closely comparable with other Indian and Far Eastern oaks; and a third form of leaf is very similar in shape and venation to a species that now has its home in China, Assam and the island of Formosa. It is noteworthy that none of the oaks of the Thulean forests conformed in pattern of the foliage to our familiar British trees.

One of the most conspicuous trees in the Hebridean woodland was a plane (*Platanus*) with large handsome leaves almost—but not quite—indentical with those of the existing occidental plane of North America. The fossil evidence in this instance is supplied by male flowers and fruit-balls as well as leaves. As in all living planes, the expanded base of the leaf-stalk enclosed and protected a bud. There is, however, one interesting feature in which the leaves of the Mull tree differ from those of any living plane: there were two fairly large leaflets attached to the long leaf-stalk between the main part of the leaf and the base of the stalk. The significance of this peculiarity need not be discussed; it is one of those botanical problems of academic interest which excite the specialist. A more important fact for us is that plane trees in the period we are considering occupied a territory which extended very much farther north than the present area of distribution. Remains of plane trees have been found as far north as Spitzbergen in rocks approximately equivalent in age to those of Mull.

There are in the world to-day six or possibly eight different kinds of plane: the oriental plane (*Platanus orientalis*), the only species native in Europe, is one of the noblest living trees; it recalls the groves of the Academy in the golden age of Greece. One of the oldest specimens is the venerable stump bearing enormous arms in the market-place on the island of Cos where—legend would have us

believe—Hippocrates, more than two thousand years ago, gave advice to his patients under the shade of the youthful tree. The oriental plane extends from Greece and the Aegean islands eastward to Asia Minor and the Caspian Sea; it is sometimes said to be wild in Persia and northern India, but more probably this eastward spread should be attributed to man. The most widely distributed species in the New World is *Platanus occidentalis*, growing usually in river valleys from lake Ontario to Florida and west to Texas and Nebraska. On the western side of North America there are other species, in Mexico and along the Coast Range hills of California. The most familiar cultivated species in Britain is *Platanus acerifolia*, the so-called London plane: this favourite urban tree is regarded by some botanists as a hybrid between the oriental and the occidental plane; the time and place of its origin are not known with any certainty.

The geological record of *Platanus* affords a striking example of contrasts between past and present areas of distribution. Some of the oldest known fossil leaves and fruits are from early *Cretaceous* beds in Greenland, at least 300 miles north of the Arctic Circle. The occurrence of these remains, in sediments that were deposited in a remote northerly estuary before the chalk of the British Isles had been upraised from the sea-floor, affords definite proof that plane trees lived in Arctic forests millions of years before they spread to the southern part of the Thulean continent. The birthplace of *Platanus* may have been in the far north, whence in course of time it spread to Iceland and Spitzbergen, from arctic to temperate North America and Europe, and wandered as far east as Sakhalin Island on the eastern confines of Asia.

One of the comparatively few trees in the Hebridean forests related to recent British species was a *Corylus* with leaves similar to those of our hazel but still more like the foliage of species now living in India and the Far East. Hazels were associated with planes not only in the ancient flora of Mull but also in circumpolar forests from which they travelled, in response to the urge of climatic change, to fresh and more genial homes farther south. Another tree in the Thulean forests was a cornel, a species of genus *Cornus*, which has a far-flung distribution, in arctic and sub-arctic countries, in North America, Europe and Asia. While fully conscious of the danger of

placing excessive trust in leaves as evidence of affinity, we believe that a Chinese cornel (*Cornus chinensis*) agrees most closely in foliage with the Mull species. The cornels are members of an old stock represented in northern forests as long ago as the *Cretaceous* period.

Among the larger fossils from Ardtun Head are a few almost perfectly preserved leaves of vine, which we believe to be specifically identical with specimens previously discovered in Alaskan rocks of approximately the same geological age as those associated with the lava-flows of Mull. Similar leaves have been described from Greenland, Iceland, Spitzbergen and more southern localities in America and Europe. Vines were widely distributed even as far back as the *Cretaceous* period: there is now only one European species, the wine-producing *Vitis vinifera*; but its leaves are unlike the fossils from Ardtun. The striking contrast between the present distribution of the vine in Europe and its former much more extended distribution which included arctic and north temperate regions raises the difficult problem of changes in climate from one age to another. Vine scrolls are a fairly common ornament on early Northumbrian Anglo-Saxon crosses, a motif adopted in still earlier ages by Greek and Roman sculptors, which, after the lapse of centuries, reached the highest expression of naturalistic treatment in England in the last two decades of the thirteenth century. Millions of years before vine leaves and fruit were fashioned in stone, one kind lived in prehuman days on the Thulean continent; and it is noteworthy that its nearest counterpart in the modern world occurs in the Far East.

We turn now to trees and shrubs belonging to genera which are no longer living in Europe. The first tree to be considered furnishes a striking contrast, in the narrow limits of its present geographical area, to the widely spread cornels and oaks. *Cercidiphyllum* is now confined to Japan and mountain valleys in some parts of China. The name *Cercidiphyllum* was chosen because of a superficial resemblance of the leaves to those of the Judas tree, *Cercis siliquastrum*; only a single species, with a few varieties, has survived, *Cercidiphyllum japonicum*, familiar to many tree lovers who cultivate it for the sake of the exceptionally beautiful gold, pink and red parti-coloured autumnal foliage. In common with some other trees of ancient lineage, *Cercidiphyllum* lacks any near relations in the

present age; it is one of a select company of Nature's anachronisms. Like the Maidenhair tree, it is an aberrant type, a relic living within a comparatively small area in the Far East: formerly it was one of the most widely distributed forest trees on both sides of the Atlantic Ocean. Several beautifully preserved leaves have been found in the plant-beds of Ardtun Head, leaves and occasionally fruits of *Cercidiphyllum* have been found in Grinnell Land and Ellesmere Land on the north-eastern corner of the Canadian Archipelago, in Alaska and at several localities on the Pacific and Atlantic coasts of North America, in Greenland, Iceland and Spitzbergen, as well as in Switzerland and other parts of Europe. Leaves, superficially at least indistinguishable from those of the existing species, are recorded from sedimentary beds in the valley of the Potamac River in Maryland assigned to the early days of the *Cretaceous* period when flowering plants were comparatively few in number and had not yet come into their own as the dominant class in the plant kingdom. When we remember the remote antiquity of *Cercidiphyllum* and its wanderings over the earth's surface during the passing of millennia, the autumnal glory of its foliage is enhanced a hundredfold and acquires a symbolic meaning.

The plant-beds on the headland of Ardtun have yielded very few recognisable fruits and seeds. Among the rare examples of fruits are some, about half an inch long, consisting of a slightly elongated seed-vessel surmounted usually by five leaflets, the enlarged and persistent covering of the young flowers, which served as efficient aids to dispersal by wind. The fossil winged fruits and associated leaves present a remarkably close resemblance to those of some living species of *Abelia,* a genus named after Mr. Clarke Abel, who discovered the shrub in China about one hundred and twenty years ago. *Abelia* is a member of the honeysuckle family (*Caprifoliaceae*): most of the existing species have their home in Central China and are cultivated as flowering shrubs in European gardens. There are a few species in Japan, the Himalayas and Mexico. Fruit of a Chinese *Abelia* agrees most closely with the fossil specimens. Similar though not specifically identical fruits were discovered thirteen years ago by Mrs. Clement Reid and Miss Chandler in a collection of fossil plants from Bembridge in the Isle of Wight. The Bembridge flora is younger geologically than the flora of Mull and

indicates a warmer climate. Other examples were recorded long ago from south-eastern France. It is therefore clear that shrubs next of kin to *Abelia* now living in China were once native in western and northern Europe. The introduction to British and Continental gardens in our time of *Abelia, Cercidiphyllum* and other trees and flowering shrubs may be described as the reinstatement—through man's desire for horticultural novelties—of plants that had long been exiles from Western woodlands, where as natives they were never seen by human eyes.

So far, attention has been confined to a selection of plants identified from leaves and a few fruits. If time permitted, the list could be substantially enlarged by inclusion of the interesting results of Dr. Simpson's intensive study of pollen-grains, which he found by microscopical examination of broken-up pieces of lignite and coal, associated with sandy beds in Mull and on the adjacent peninsula of Morven. The pollen-bearing layers of rock are below the basaltic lavas and therefore slightly older than the leaf-beds of Ardtun Head. Dr. Simpson discovered several conifers and flowering plants confirmatory of identifications based on leaves; he also made many additions to the list compiled from leaves, fruits and seeds. Three of his discoveries are selected for brief reference. He found pollen-grains of two kinds of alder (*Alnus*): the pollen of alders has a very characteristic structure and can easily be recognised. The occurrence of alders in the Hebridean flora supplies one of the few links between the extinct and the present European vegetation. The second genus chosen from Dr. Simpson's list is *Magnolia*: it is now represented by many species both trees and shrubs, and is widely distributed on two sides of the Pacific Ocean: in Asia along the Himalayas and in parts of Tibet, over a large area in China, Japan and Korea, the Malay Archipelago and Indo-China; in America from southern Ontario as far south as Central America and Cuba. It was shown many years ago that *Magnolia* formerly lived in Europe and flourished as far north as lat. 70° N. in Greenland; we now know that it played a part in the adornment of the Thulean forests.

Finally, a few words on the discovery of pollen-grains believed to belong to a species of *Nelumbium*: this genus is one of the most attractive water plants, a plant held sacred in ancient Egypt and venerated in the Far East. One of the living species is the sacred lotus,

native in China and Japan and established as far west as the Caspian Sea; the other species has an extended range in North America, spreading as far south as the West Indies and Brazil. *Nelumbium* no longer grows in the Nile: long years ago it had a wide distribution in Europe, both in the *Cretaceous* period and in later ages. Looking backwards, we see its great circular leaves spread over the still waters of a Thulean lake.

It is important to note that Dr. Simpson's comparative investigation of fossil and recent pollen shows a preponderance of eastern Asiatic species in the Hebridean flora.

Fancy With Fact.—We have attempted to re-create a scene in the past, and it is natural to ask: How does our reconstruction compare with reality? As it is impossible to satisfy curiosity by an actual flight to the Thulean continent, we can at least imagine ourselves miraculously transported to a destination where the past has become the present. At a very early stage of the backward journey we should see the greater part of the land being gradually obliterated by a covering of snow and ice; glacial conditions would be succeeded by a climate becoming more and more genial. Human beings would be missed before one-fiftieth of the flight had been completed. At last, after observing the moving panorama of land and sea, fluctuations in climate and changes in the character of the vegetation, let us imagine ourselves at the journey's end. Combining fact with fancy, we find ourselves—where in day-dreams we have often been—among the plants on the lava plateau. Thanks to the artistic co-operation of Mrs. Gwendy Caroe, it has been possible to give substance to our mental picture based on geological and botanical facts. It requires a special effort for us, who think of ourselves as overlords in Nature's realm, to visualise a world in which man has no place. Alone in a world which for millions of years to come would be uninhabited by the human race. We could scarcely fail to look upon the beauty of Nature's pageantry with a strange and more penetrating vision:

> "Beauty, the eternal Spouse of the Wisdom of God and Angel of his Presence thru' all creation."

We should realise as never before man's insignificance: on the other hand, our estimate of the spiritual values would be raised to a higher level and we should experience a deeper sense of union with the infinite. Our tendency is to think of the past, as we think of the

present—in relation to man; we forget his very recent participation as an actor in life's drama. As we look at Nature as into a mirror, our own image obtrudes itself into the foreground. Had man been a dweller on the Thulean continent, he would have seen, as we see, the sun by day setting in motion the living machinery of trees and herbs; the splendour of the evening sky; he would hear the wind in the trees, the music of running water and the songs of birds. The Beauty of Nature is eternal. To the east and north of the lava-fields the Caledonian mountain ranges would be seen rising to greater heights than any of their peaks reach to-day; they were still to be exposed for millions of years to the destructive operation of Nature's sculpturing tools. Making a fresh demand upon our imagination, let us take a longer view over the curve of the earth towards the heart of Europe and far to the east to northern India. We should look in vain for the Pyrenees, the Alps, the Carpathians and the Himalayas: these and other mountain ranges had not yet been lifted up; the time of their birth was not far off. We should see in their place a broad belt of water stretching from the Atlantic to the Indian Ocean, linking West with East. On the bed of this ancient sea—the Tethys Sea of geologists—sediments had long been accumulating, and these, with other rocks of igneous origin, would be involved at no distant date in a complete transformation of the earth's features and the crumpling of the crust into the "everlasting hills."

Returning to the Thulean continent at a place near the present geographical position of the Inner Hebrides, let us take a survey of the vegetation. We should be impressed by its luxuriance: at first sight the general aspect would seem familiar, but on closer examination of the trees and shrubs we should find only a few recalling modern European species; many would remind us of exotic plants of Eastern origin. Despite the immensity of the time interval separating us from the world we had left, we should not be aware of any such marked contrast in the general character of the vegetation as we might have expected. The plants had already put on their familiar dress and would seem to us surprisingly modern. But—and this would be the deepest impression—we should feel that we were among trees and shrubs that were reminiscent of remote Eastern forests. We should be conscious of the dynamic character of the plant-world; we should be driven to the conclusion that the forests

were mainly composed of wanderers resting for a time in a temporary home whence, as conditions changed they would pass to other stages in the long journey to their present refuges in Asia.

Evolution.—There remains another question which is always asked by those who attempt to reconstruct the vegetation of past ages: What contributions do the records of plant-life make towards a better understanding of evolution? The riddle of evolution remains a challenge and, as knowledge increases, we make fresh guesses. As a Cambridge friend writes in a recent volume of "Provocative Verse:"

"That life evolves was guessed of yore,
Darwinians prove it true;
Of how and why we know but little more
Than old Lucretius knew."

The little more we know urges us to continue in hopeful expectancy the long and endless prying into Nature's methods. What then do we learn from the ancient flora of the Western Isles?

The facts do not substantially help us to trace the unfolding of life in the long interval separating the older part of the Tertiary era from the present time. There is little difference between the past and the present vegetation of the world as a whole in the nature of trees, shrubs and ferns: our knowledge of the earlier history of the herbaceous plants is very meagre. The fossil flora of Mull represents an early phase of what may be called the modern type of vegetation, which overspread the world in the later stages of the *Cretaceous* period and has persisted with few major modifications until now. Evolution seems to have been characterised by bursts of production when new and successful types exercised a transforming influence; and these periods of exceptional creative activity were separated by periods of relative stability. The early Tertiary flora belong to a stage when a new order had become well established and an older order had passed its prime. The one great difference that emerges from comparison of the Mull flora and the existing European floras is not a difference in the components of the world forests, but a contrast in the geographical positions occupied by the various genera in the northern hemisphere: for the most part a Western home has been exchanged for a home in the Far East,

Drifting Continents.—If we followed the vegetation on the southern part of the Thulean land farther to the north, we should be impressed by its apparent indifference to changing physical conditions as we travelled beyond the Arctic Circle; we should fail to notice any zonal distinguishing characters in the floras such as in our day reflect the passage from temperate to arctic regions. The evidence of fossil plants forces us to the conclusion that the vegetation on the Thulean continent, its northern boundary within a short distance of the polar sea, its southern border on the latitude of northern Ireland and western Scotland, was astonishingly uniform. How, we ask, can we explain this surprising and well-attested fact? There must, it is generally agreed, always have been climatic belts: high arctic and much lower temperate regions cannot have supported closely comparable floras possessing several species in common. Some of us are convinced that changes in geography from one period to another, land connexions where there are now arms of the sea, interference with paths of ocean currents and consequential changes in temperature are inadequate as explanatory causes. What then remains? Were it possible for us to make a survey of the Thulean continent as it was, we might find that the geographical relation of the northern part of the forest-clad land to the North Pole was by no means the same as it is now.

It is difficult—it is probably impossible—to explain the facts without calling to our aid the hypothesis of drifting continents usually associated with the late Professor Wegener and recently discussed in an able book by Professor A. L. du Toit of South Africa. This is a controversial subject beyond the scope of my address: I can do little more than reaffirm adherence to the view that plant records from rocks of many ages raise problems which seem to be insoluble unless we postulate movement and sliding of the earth's crust. As icebergs are slowly drifted by ocean currents, as masses of cumulus clouds rapidly changing shape pass across a blue sky; so— the rate of travel enormously reduced—large slabs of the outermost rocky shell of the world may have shifted their position in the course of geological time. It must, however, be admitted that as yet refined methods of measurements have not furnished any evidence of crustal movement. Dr. Norlund of Copenhagen has stated that longitudinal determinations, carried out by the Danish Geodetic Institute in

1927 and 1936 with a modern transit instrument, both times on the same pillar at a locality on the west coast of Greenland, gave practically the same result. In his presidential address at the Norwich meeting of the Association in 1935, Professor W. W. Watts made an interesting and judicial reference to the Wegener hypothesis: he spoke of it as having been hailed by many classes of investigators as almost a panacea, and quoted one of several critics who called it a beautiful dream, the dream of a great poet.

Proof or disproof of the Wegener hypothesis will be forthcoming in the more distant future, when the precision of modern methods of measurement has been available long enough to provide trustworthy data. Meanwhile, we must be content to wait in sanguine expectation that an interpretation of the overwhelming evidence furnished by fossil plants will be provided by research workers in the geographical field.

One of the most impressive examples of the bearing of fossil plants upon the fascinating problem of climatic conditions in the past has been furnished by Professor T. M. Harris of Reading. The facts are briefly these: several years ago Professor Nathorst of Stockholm described a large collection of fossil plants from rocks in Scania, the southernmost province of Sweden, demonstrating the existence of a flora many million years older than the one we have been considering. It was a very rich flora composed of numerous ferns, conifers and other plants; it probably lacked flowering plants. More recently, Professor Harris made a still larger collection of fossils during a long visit to eastern Greenland in the ice-bound district of Scoresby Sound where, under extreme arctic conditions, only a few stunted plants are able to exist.

Nothing could be more striking than the present contrast between the floras of eastern Greenland and southern Sweden. The arctic fossil plants of the same age as those from Scania demonstrate the former existence of a flora even richer than that from southern Sweden: comparison of the two floras affords no indication of any difference in the size of individual plants and no difference in the vegetation as a whole. A luxuriant and uniform vegetation occupied an area stretching from central Germany to southern Sweden and a thousand miles farther north beyond lat. 70° N. The fossils preserved in rocks at localities within this far-flung geographical area from

south to north give no indication of any such change in the plant communities as we should expect and as we find when we contrast arctic and temperate floras in the present world. This uniformity, I venture to think, is inexplicable unless we assume a very considerable movement and reshuffling of the earth's crust. The geological historian needs the co-operation of astronomers and physicists in his endeavour to reconstruct the world at the successive stages of its development; he looks to them to prevent him from making assumptions inconsistent with conclusions reached by workers in other fields. On the other hand, geologists and paleontologists contribute facts that are incontrovertible however much they seem to be in opposition to the views of students whose primary interest is in geophysical problems.

Neglect of Earth History in Education.—There are still some people who ask, What is the use of the kind of information given in this address? My reply is that knowledge gained from a first-hand study of Nature, both animate and inanimate, has a value beyond price. Enjoyment of the romance of creation as recorded in the life of the past and of the present is within the reach of all who have the desire to read the open pages of Nature's book. In the rocks we find the soul of history: the whole world throbs with life, and the joy of it all is ours to share:

"I said it in the meadow path,
  I said it on the mountain stairs—
The best things any mortal hath
  Are those which every mortal shares."

We have caught here through the mists a glimpse of a scene on earth's stage separated from the present by a small fraction of time in relation to the whole span of geological history. The Thulean forests which we have visited included trees, shrubs and other plants of surprisingly modern aspect, though it is not to be supposed that they were absolutely identical specifically with their living descendants; from the material available it is impossible to define or assess the difference. What we have seen throws little light on the evolution of the plant-world; it is equally true that the main conclusion forced upon us by our retrospect cannot fail to convince us that it is impossible to understand the present distribution of plants over the earth's surface unless we extend our survey into the past. Darwin spoke of geographical distribution as a noble science "almost the

keystone of the laws of creation." The living world cannot be fully appreciated as an expression of creative energy unless we free ourselves from the cramping influence of the environment in which we live.

As a botanist whose first love was geology, may I make a plea for a wider recognition of physical geography and geology as branches of knowldge possessing an inestimable value as a means of bringing young people into close companionship with Nature and as a source of refreshment, a stimulus and an inspiration. Most of us would probably agree with the spirit of a remark made a good many years ago by the late A. C. Benson: "I find it hard to resist the conviction that, from the educational point of view, stimulus is more important than exactness." Arguments in favour of introducing geology into schools were put forward in a report on scientific education presented at the Dundee meeting seventy-two years ago, and in 1936 and 1937 the Association published two reports on the same subject. Let me add another argument of no little value: Hugh Miller wrote in a letter to a friend: "Geology is, I find, a science in which the best authorities are sometimes content to unlearn a good deal." That is worth much: geology helps us to cultivate the not-too-common virtue of admitting that it is possible to make a mistake.

In conclusion, I cannot do better than quote with wholehearted agreement words spoken by Sir William Bragg in his presidential address to this Association eleven years ago: "Some speak of modern science as tending to destroy reverence and faith. I do not know how that can be said of the student who stands daily in the presence of what seems to him to be infinite." These words apply with equal force to searchers after truth whose main interest is in the living world, no less than to those whose objective is the elucidation of the structure of matter that is called by contrast dead and yet vibrates with life. The earth was once lifeless: when and how living protoplasm had its birth we do not know, nor do we know whereupon were the foundations of the earth laid. We can only echo in our hearts the voice out of the whirlwind:

"Whereupon were the foundations thereof fastened?
Or who laid the corner-stone thereof;
When the morning stars sang together,
And all the sons of God shouted for joy?"

—*Nature,* Vol. 144, No. 3644, September 2, 1939.

INDIAN FORESTER

JUNE, 1940

TWO NEW INDIAN SPECIES

By R. N. De

Pogostemon Dasianum De et Mukerjee, sp. nov.

By

R. N. De, I.F.S.

and

S. K. Mukherjee,

Curator of the Herbarium, Sibpur, Calcutta.

Species distinctissima, P. MacGregori W. W. Smith, floribus similis, sed foliis minoribus, bracteis majoribus conspicuis, verticellis paucifloris differt.

Erect branching herb, about 35 cm. high, minutely and softly tomentose all over with adpressed hairs. *Leaves* petioled, ovate, obtuse, widely and often doubly serrate, except near the entire rounded or cuneate base, softly tomentose on both sides, pale beneath; lamina 1.5-4 cm. long, 1-2.2 cm. broad; petiole 3-10 mm. long. *Spikes* terminal, dense at first, becoming much interrupted when fully developed; whorls few-flowered, lower often axillary; bracts conspicuous, petioled, lower usually ovate upper lanceolate or elliptic, usually entire, 3-13 mm. long, 1.5-7 mm. broad. *Flowers* minute, shortly pedicelled, *Calyx* 2 mm. long in flower, almost double in fruit, tubular-companulate, densely hirsute; teeth 5, subequal, ciliate, shorter than the tube, the uppermost tooth triangular, acute, other teeth subulate. *Corolla* 4 mm. long, pubescent outside, tube exserted, limb subequally 4-lobed; lobes spiculate. *Stamens* exserted; filaments pubescent below. *Disc* equal. *Nutlets* minute, ovoid, smooth and glabrous.

ASSAM.—Shillong, Government Fruit Garden, G. K. Deka, No. 17721 *(type in Forest Herbarium, Shillong).*

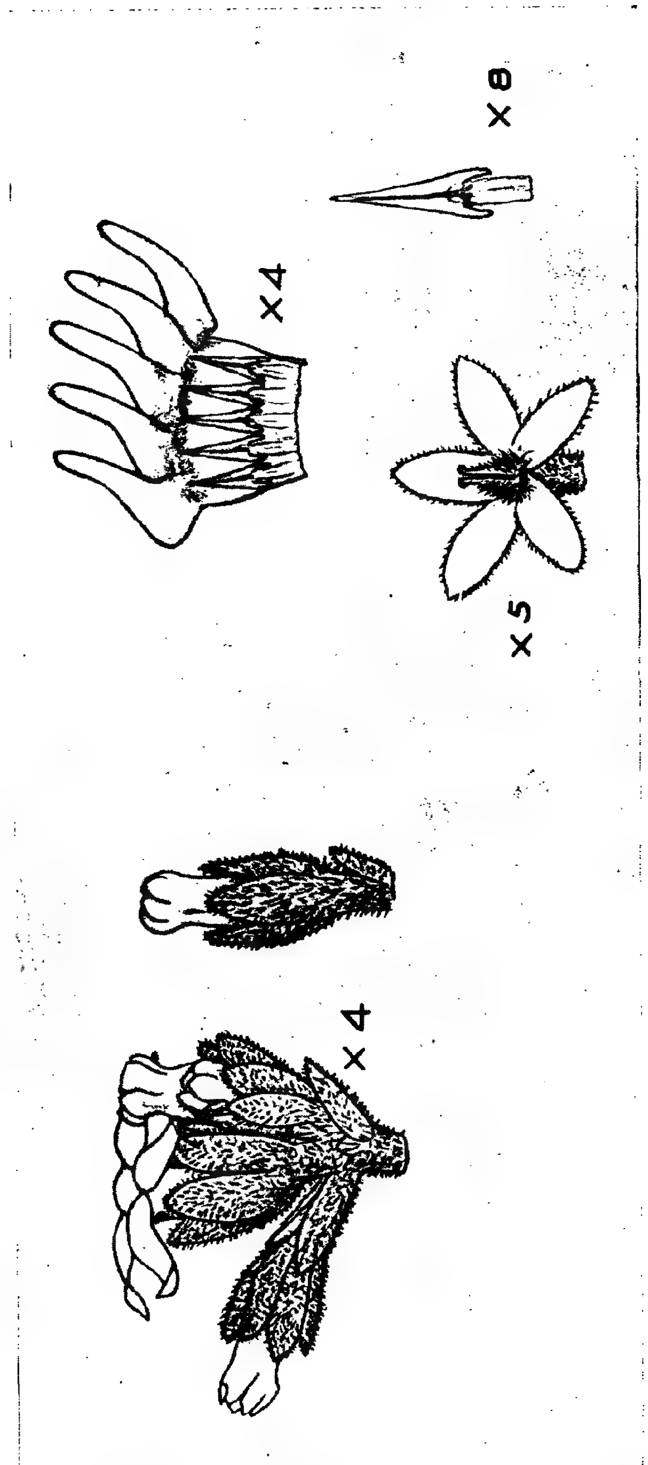
Micrechites Sabitae De et Narayanaswami sp. nov.

BY
R. N. De, I.F.S.
and
V. NARAYANASWAMI,
Botanical Survey of India

M. ellipticæ Hook. f. affinis, sed ab ea nervis lateralibus foliorum paucioribus, remotis; floribus cymosis paniculis dense hirsutis congestisque dispositis; calycis lobis oblongis, obtusis, hirsutis, corollæ tubo æquantibus recedit.

A climbing shrub 5 to 7 metres high, branches chocolate-brown, terete, glabrous; nodes with a linear scar between the leaves. *Leaves* simple, opposite, entire, exstipulate, narrow oblong-elliptic, acuminate, 7-13 cm. long, 3-5 cm. broad, glabrous, coriaceous, base cuneate petiole 1-2.3 cm. long; nerves 8-10 pairs, more distant than either in M. polyantha Miq. or in M. elliptica. *Flowers* in short axillary or terminal, congested, cymose panicles, ferruginous-hirsute; bract oblong-ovate, obtuse, hirsute; bracteoles 2, narrow-oblong, acute, brown-hirsute dorsally, glabrous inside. Calyx 5-partite nearly up to the base; lobes imbricate, two outer and three inner, the outer ones being bigger and broader than the inner ones, ferruginous-hirsute dorsally, nearly equal to the corolla tube, oblong-ovate, obtuse or acute; two small ovate membranous white glands at the base of each lobe on the inner side, mixed with hirsute hairs between them; gland sometimes emarginate or bilobed. *Corolla* white, 5-6 mm. long, hypocrateriform; lobes 5, twisted to the right, folded inwards in bud, lobes very oblique, narrow, deflexed to the right, 2-3 mm. long, tube glabrous, mouth naked, throat minutely hirsute inside. *Stamens* 5, epipetalous at the base of the corolla tube, included, conniving into a cone round the ovary; anthers basifixed sagittate, bases prolonged downward into bent spurs. *Ovary* of two, free, ovate carpels 2 m.m. long, densely brown-hirsute dorsally; style short, stigma clavate, cupular at the top with lobed edges. torus densely hairy. *Fruit* of two divergent follicles, narrow-terete, 7-20 cm. long, glabrous; seeds many, flat, 1.7-2 cm. long, oblong, truncate above with a persistent coma of white hairs about 3 cm. long, pointed below. (Plate 15).

MICRECHITES SABITAE DE ET NARAYANSWAMI, sp. nov.



KHASI AND JAINTIA HILLS.—Cherra Road, 22nd Mile. Sriram Sarma No. 10139 (*Type in Forest Herbarium, Shillong*).

This species differs from Micrechites elliptica *Hk. f.* in having (*i*) fewer distant lateral nerves on the leaves, (*ii*) short, densely hirsute, congested, cymose panicles which are lax and glabrous in M. elliptica and (*iii*) large, oblong, obtuse and densely hirsute calyx lobes which are almost equal to the corolla tube.

M. Sabitæ var. laxiflora DE et Narayanswami var. nov. a typc inflorescentia laxa glabraque recedit.

KHASI AND JAINTIA HILLS.—22nd Mile, Cherra Road, Sriram Sarma, sheet No. 12785 (*Type in Forest Herbarium, Shillong*).

This differs from the type species in having lax and glabrate inflorescence, although it agrees in all other respects.

The specimens could not be matched either at Kew or the Royal Botanic Garden, Sibpur.

A NOTE ON *ISCHAEMUM ROBUSTUM* Hook. f.

BY N. L. BOR

In the Flora of British India, Vol. VII, page 139, Sir J. D. Hooker published the description of a new species of *Ischaemum*, based on a sheet of Brandis' in the Calcutta Herbarium. This species he named *Ischaemum robustum* Hook.f.

In the herbarium of the Forest Research Institute there is a sheet, No. 3139 Herb. D. Brandis, collected by Brandis in 1864 which bears in his handwriting "Pauni in Bursahir, alt. 7,000 feet.", a note which Hooker quotes under the distribution of his new species from the Calcutta sheet on which he based this species. The grass on this sheet is undoubtedly *Phacelurus speciosus* (Steud.) C. E. Hubbard.

Recently during a visit to the herbarium of the Royal Botanic Garden at Sibpur I was able to see the type sheet of *Ischaemum robustum* Hook. f. Again in this case, the grass is *Phacelurus speciosus* (Steud.) C. E. Hubbard and is a part of same gathering as the Dehra sheet.

It seems, therefore, that the name *Ischaemum robustum* Hook. f. must be merged in the synonymy of *Phacelurus speciosus* (Steud.) C. E. Hubbard.

The genus *Phacelurus* Grisebach [Spicil. Fl. Rum. II (1844) 423] was treated as a subgenus of *Rottboellia* by Hackel [in D. C. Mon. Phan. VI.—*Andropogoneae* (1889) 279] and by Hooker [in Flor. Brit. India, VII (879) 139]. Our species is called *Rottboellia speciosa* Hack. in those works; based on *Andropogon speciosus* Steudel Syn. Pl. Glum. I. (1854), 375.

Mlle. A. Camus appears to have erected a new genus *Pseudophacelurus* in 1921 and to have transferred *Rottboellia speciosa* Hack. and *R. latifolia* Steud. to it. There does not seem to be any valid reason why the genus *Phacelurus* of Grisebach should not be maintained and Hubbard transferred *Rottboellia speciosa* Hack. to it in 1928, making the new combination *Phacelurus speciosus* (Steud.) C. E. Hubbard.

The synonymy of the species seems to be as follows:

Phacelurus speciosus (Steud.) C. E. Hubbard in Kew Bull. (1928) 35.

Andropogon speciosus Steud. Syn. Pl. Glum. I (1854) 375.

Ischaemum speciosum Nees apud Steud. loc. cit. 375.

Andropogon corollatus Nees apud Steud. loc. cit. 369.

Ischaemum corollatum Nees apud Steud. loc. cit. 369.

Vossia speciosa Benth. in Journ. Linn. Soc. XIX (1882) 70.

Ischaemum corollatum (Steud.) W. Watson in Atkins., Gaz. N. W. Ind. (1882) 392.

Rottboellia speciosa (Steud.) Hack. in D. C. Mon. Phan. VI. Androp. (1889) 282.

Ischaemum robustum Hook. f. in F.B.I. VII, 139.

Pseudophacelurus speciosus (Steud.) A. Camus in Bull. Mus. Nat. Hist. Paris, XXVII (1921) 370.

SAL REGENERATION *DE NOVO*

By W. D. M. Warren

On returning from leave I was very interested in reading Mr. Smythies' article on "Sal Regeneration *de novo*" in the October issue of the *Indian Forester*.

The United Provinces are to be congratulated upon having at last found a solution of their sal regeneration problems, after being baffled for so many years. And yet neither Mr. Smythies nor other

officers of that Province would, I think, wish to claim that the last word had been said on this important subject.

We in Bihar have at times, I think, been somewhat puzzled to learn that sal regeneration should be such a problem in Assam, Bengal and the United Provinces, for with us in Singhbhum we get as much regeneration as we desire, lying dormant, in our fairly close canopied forests, awaiting the day when the woodman's axe shall free it. In fact we were not long in discovering that with regeneration nearly everywhere in the whippy stage, it was not necessary to proceed cautiously, by the successive regeneration fellings method, in the regeneration of our coupes. Instead, we now proceed boldly, leaving only six to eight stems per acre to act as mother trees to stiffen up the regeneration in places where it may possibly be scanty. No wonder then it took us some time to appreciate the troubles which have beset other Provinces.

It is necessary, of course, after fellings, to carry out two or three rains cleanings a year in our damper areas until the regeneration has grown above the weed belt.

Other Provinces have resorted to firing in order to induce sal regeneration, a method never seriously adopted here and long since abandoned as being not only unnecessary but actually detrimental in its effects. Yet one must admit that there seems to be a justification for Bengal and Assam adopting it to get rid of the *Imperata* grass which prevents the sal seeds from reaching the ground. It was Mr. Owden, himself an Assam man, who pointed this out to me, stating that until the thick matted grass had been got rid of sal seeds could not hope to germinate under favourable conditions. I notice, however, that in Goalpora, firing alone is not sufficient, and that the pulling of weeds twice in the rains has been resorted to (De).

In the United Provinces, annual burning is practised in order (*a*) to get rid of the leaf layer and (*b*) to keep down weeds. It is suggested, however, that (*a*) is not really a decisive adverse factor, otherwise why is it not decisive in Singhbhum? By this I do not mean that a layer of leaves does not prevent some sal seeds from germinating under conditions which would ensure their survival, but sufficient seeds somehow do seem to reach the soil to give us the amount of regeneration we require. One of the disadvantages of

annual burning is that it kills out all seedlings of that year and possibly all those of the preceding year also. Chaturvedi proved that in his experiments in the United Provinces some years ago; and all our sal research experiments have proved the same thing. We have sometimes found that at the periodic recounts we had less seedlings on the annually burned plots than we started with originally and in no case has the recount been equal to or greater than that obtained in the unburned controls. In fact it is probably true to say that if there has been any increase in the number of the seedlings in the burned plots it has been due to the incompleteness of the burn. Material for a good burn begins to get short after a few years!

The United Provinces, realising that annual burning is inimical to sal seedling growth, stop burning in a good seed year and for the following year. This procedure, coupled with perhaps the incompleteness of some of their annual burns during years of poor seeding, enables them to get up their sal regeneration.

If cutting back instead of burning were adopted, it might prove expensive as apparently it may take from seven to fifteen years for sal regeneration to reach the whippy stage, and then cutting back would not get rid of the leaf layer, although, as I have already pointed out, that may not be a decisive factor.

Climatic conditions.—I did not write this article merely to discourse on the merits and demerits of annual burning as an aid to establishing sal regeneration, but to endeavour to discover the real cause for the difficulties which the United Provinces are having to face. The real cause, I think, is to be found in the remarks which Mr. Smythies makes upon the climatic conditions which prevail when the sal seeds begin to fall from the middle of May until the middle of June. Sal seeds are known to be very perishable and to die if, within a week of falling, ideal germinating conditions have not arrived. Mr. Smythies thus laid stress on the value of the early monsoon. On the other hand, "persistent and heavy rain in July and August causes the young seedlings to damp off in millions.... In fact an early but weak monsoon seems ideal for Bhabar sal forests." He, however, prefaces these remarks with the observation that the climatic factor is "beyond our control."

This last remark made me "sit up." Is it true to say that the climatic factor is beyond our control? I scarcely think so. Climatologists will tell you that it is quite possible to modify a forest climate by converting arid to luxuriantly growing forests. Consequently, we must not rule out the modification of climate as an aid to establishing sal regeneration.

The second question to ask is: "Are the sal regeneration troubles of the United Provinces, taking Singhbhum conditions as ideal and the control, due to climatic or to other causes? If to climatic causes, then the rainfalls of May and June, in selected stations of both areas, should reveal the true position.

The following are the rainfall figures:

SINGHBHUM

		May	*June*
Chaibassa	...	3.23 (3.48)	8.76 (10.75)
Chakardharpur	...	3.17 (5.29)	9.25 (11.25)
Sonua (last 4 years)	...	(3.52)	(12.35)
Goilkera	...	2.27 (2.47)	10.05 (10.22)
Manharpur	...	2.05 (2.09)	10.89 (9.07)
Bamiaburu (3 years)	...	1.90 ...	8.26 ...

UNITED PROVINCES

		May	*June*
Dehra Dun	...	1.57	8.29
Hardwar	..	.92	5.71
Bahraich	...	1.51	5.89
Gorakhpur	...	1.36	6.97
Saharanpur	...	.76	4.20
Pilibhit	...	1.08	6.47
Naini Tal	...	3.21	14.60

It will be seen that, with the exception of Naini Tal which is not in the sal zone, not a single U.P. station compares favourably with the Singhbhum stations for May rainfall and even for June, Dehra Dun is the only station which approaches the Singhbhum figures. [The figures in parentheses for the Singhbhum stations are those for the last four years, which include 1939, a very dry year. In spite of this, they show an increase on the normal till 1932.]

These figures show fairly conclusively that the chief factor, operating against the influx of sal regeneration in the United Provinces, is the climatic factor. Can that factor be modified to aid sal regeneration? It seems so. Dr. Visher, a Climatologist of Indiana University, U.S.A., says: "There is no doubt as to the decided effect upon soil moisture of contour trenching. This increase in rainfall absorption greatly stimulates plant growth and this in turn alters the climate of the immediate locality (in the forest and in the close vicinity)."

Although our own records have not been going long enough to prove climatic change, yet we have had three years, out of four of good May rainfall at Bamiaburu. In 1938, we had 3.54 inches of rain and 19 rainy days, the first shower commencing on the 6th May, and yet there was little to indicate in the records of Bengal or of distant Chota Nagpur stations that this was an exceptional year of early rain. The effect on the influx of sal regeneration has been most gratifying. That effect is to be seen not only in what were formerly arid sal forests but in the valleys below.

I do not say that the United Provinces can hope to produce as good May rainfall figures as Singhbhum. That could hardly be as they are much farther from the sea (the chief source of rainfall) than we are. But if they can cause every wandering cloud of May and early June to precipitate some of its moisture, as we appear to be doing at Bamiaburu, they will, I feel sure, have done much to hasten the influx of sal regeneration. When that happy stage is reached, I anticipate annual burning will become unnecessary, as it is now with us.

In Mr. Smythies' note of April, 1936, "Seedling regeneration in B-3, sal," he points to the fact that in the heavily grazed Nepal forests sal regeneration presents no difficulty, and suggests that cattle grazing, instead of being a confounded nuisance, may possibly be a useful factor. But it is possible that the climatic factor in Nepal may be more favourable than in the U.P. forests and so may possibly account for the better sal regeneration found there. Nepal sal forests, I presume, are higher than those of the U.P. and winds which have been cooled down in the U.P. Terai forests would perhaps be more inclined to deposit their excess rainfall in Nepal,

Only a study of rainfall figures of May and June in Nepal can settle this point. In Singhbhum where the climatic factor is favourable, grazing is prohibited, which shows that grazing is not an essential factor to the establishment of sal regeneration.

Canopy conditions.—I had intended finishing my note at this point but since then I have felt that I should say a word on canopy conditions. It has already been mentioned that we proceed direct almost to a clear felling leaving only a few "mother" trees per acre. Mr. Smythies mentions the case of Lakhmanmandi I, Haldwani Division, where in 1927 the canopy was opened "pepper-pot" fashion. Such a canopy description aptly describes the conditions found on Experimental Plots 18—31 Saranda, in Karampada Block where in January, 1939, I analysed the periodic recounts of sal seedlings on plots subjected to different treatments since 1929. My summary reads as follows: "In assessing the value of these results, the most important point to remember is that there is an adverse factor affecting practically every plot to a more or less degree. That factor is root competition from the overwood causing the regeneration to suffer from drought. The factor is considered to be root competition and not lack of light, since the sal leaves of the regeneration are in a perfectly healthy condition, not etiolated as they would be were the light conditions adverse. Further support for this view is obtained from the fact that many of the sal seedlings showed withered Cotyledon leaves even in the cold month of January, 1939, due to drought. Frost is out of the question on this area. Drought causing withering can only be due to root competition at this time of the year. Then, again, much of the regeneration one to three feet high has grown very little during the last ten years. Some of it, as the graph records show, is smaller now than it was then in spite of fire protection on all plots since 1935. Cases were noticed in the field in January where some regeneration two feet and three feet high had died back up to six inches at the tip. Contrast this with experience of Santara 16, Bamiaburu where, under a closer canopy than that found on these plots, the sal regeneration under the influence of contour trenching 25 yards away and so with ample soil moisture, shot up from two to three feet high to 15 to 18 feet in four years! The adverse factor of the Saranda plots varies in every plot and seems

to be quite sufficient in some plots to mask the beneficial effects of some of the aids introduced to stimulate the sal regeneration."

In other words, if sal regeneration is to be stimulated in its growth, competition for the existing water supply in the soil must be reduced by making drastic openings in the canopy. When one thinks matters out carefully, one realises that this must be so. It is essential that sal seedlings should penetrate deeply after one or two years' growth to get down to the permanently moist levels and so are bound to come into hopeless competition with the massed roots and rootlets of the established overwood which are sucking up all the available moisture. Root studies and diagrams at the Forest Research Institute show how quickly the tap roots of seedlings penetrate deeply into the soil Teak root and shoot cuttings, for instance, penetrate about five feet in the first year.

Canopy opening is, therefore, of vital importance.

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THE DHALBHUM FOREST DIVISION

AN EXPERIMENT IN PRIVATE FOREST MANAGEMENT

By J. N. Sinha

There are vast areas of private forests in Bihar. By rough calculation, 7,500 square miles of forests are privately owned against 2,000 square miles under Government management. The private forests are under no pretence of scientific management. The people cut them as they like and waste more than they utilise. There are

occasionally fights between the tenants and the zemindar-owners, for the former claim indefinite rights in the forests without let or hindrance and the latter do not allow it. The tenants generally get the better of the fight and spite generally abets the destruction of the forest. Where the zemindar is able to protect the forest he does so only against the tenants, but sells or cuts it recklessly himself and does nothing to conserve or improve it. Rights in forest are not properly defined in the revenue settlement. Forest was considered as too inexhaustible to bother about regulation of rights in its produce. Forest has in consequence been fast deteriorating and disappearing, leaving the once fertile land to erode into gullies and desolate waste.

Chota Nagpur is the principal forest-bearing tract and it is hilly or undulating. The consequences of forest destruction have long been apparent. Ranchi District has already become a comparatively forest-less waste. In Manbhum, Hazaribagh and Santal Parganas districts, forest destruction has also been going on apace—in the last named district, particularly, whole hills have been laid bare by the local *paharias* for shifting cultivation.

The Government of Bihar has for some time felt anxiety about the consequences. The toll of floods could not be overlooked and the erosion of soil and consequent impoverishment and gullying of land have slowly been making themselves evident. But private individuals held the forest. They would not give up their immediate interests in favour of the ultimate national interests. There were conferences and consultations but nothing tangible resulted until a few years ago. A scheme of lease (under Section 38 of the Indian Forest Act) was then devised. Under this scheme the owner would lease out his forest to Government for a definite period (it is generally 45 years in Bihar) in return for a fixed annual rental (generally one anna per acre per annum) plus half the net profits. The scheme proved successful and quite appreciable areas in Ranchi and Singhbhum Districts have thus come under Government management.

The same scheme with necessary minor modifications was extended to the Dhalbhum forests. The Dhalbhum forests are situated in the important catchment area of the Subarnarekha river. They lie in the Civil Sub-division of Dhalbhum and have the advantage

of being almost all owned by a single zemindar, the proprietor of Dhalbhum Estate. There are a few tenure-holders also who are owners of scattered forest areas interlocked with or adjoining the Estate forest and who have not come to terms with Government. The area of such forests, however, is comparatively small. Here, as elsewhere, rights were completely vague and the feelings between the zemindar and tenants were not very happy. This situation resulted in wholesale destruction of parts of the forest for sheer spite.

For 25 years ending in 1929 the forest of Dhalbhum Estate, together with the agricultural land, had been leased out to the Midnapur Zemindari Company for management and collection of dues on a commission basis. During the period all big sal trees were picked out and cut down and exported. There were no extraction facilities and the costs were high, but so long as any profit was earned the sale of timber was considered justified.

When the present Zemindar succeeded he made an effort to put the management of the forest on a proper footing. He employed a forest staff and spent money, but the tide of destruction could not be stemmed. There was large expenditure but little revenue. Matters were thus ripe for him to come to an agreement with Government and accordingly a lease-hold agreement was signed on the 20th December, 1936. The Dhalbhum Forest Division was created on January 2, 1937. The salient points of the lease are as follows:

(1) The lease runs for 45 years.

(2) A list of villages was prepared, the forests of which Government could reserve, or protect, under the Indian Forest Act.

(3) The expenditure on account of the Forest Settlement Officer and his staff and the costs of survey and demarcation to be borne by Government; but the owner to pay the costs of settlement arising under Sections 11, 15, 16 and 18 of the Indian Forest Act (*i.e.*, costs of acquisition of other forests or commutation of rights, etc.).

(4) The owner to be paid rental with effect from the 1st April, 1936, annually for the first ten years and triennially for the rest of the period at the rate of one anna per acre per annum on the total acreage of reserved and protected forest. The net profits, if any, after deducting this rental, will be divided between the owner and the Government in equal proportions.

(In view of the heavy costs of forest settlement it was mutually agreed that the proprietor will forego his rental for the first five years.)

(5) If the Divisional staff also manages forest other than the estate's, then the cost of management will be allocated in proportion to the areas of the respective forests, but expenditure incurred solely on any one forest shall be debited to that forest.

The same principle will be observed in allocating revenues.

(6) (*a*) For the first ten years the debit balance of one year shall not be carried forward to the following year.

(*b*) For the subsequent 35 years the account will be worked on a three-year basis, and the deficit, if any, shall not be carried forward to the succeeding triennial period.

(*c*) Copy of the yearly revenue and expenditure account to be sent to the owner who shall not be entitled to dispute its correctness.

(7) Capital expenditure on roads and buildings to be treated separately from all other expenditure. This will be debited to "R—Loans and Advances" and will be recovered during the currency of the lease by deduction in instalments (instalments to be decided by Government) from the net profits available for distribution between the owner and Government. The "Loans and Advances" will be free from interest.

All roads and buildings so constructed shall on the expiry of the lease pass to the owner.

(8) The owner not to bear any portion of the pay and allowances of the Divisional Forest Officer for the first ten years reckoned from 1st April, 1936. During the subsequent period of 35 years the owner shall pay triennially a contribution equal to $12\frac{1}{2}$ per cent. of the profits which accrued in the previous triennial period or the proper share of the pay and allowances (if the Divisional Forest Officer is in charge of other forests also) calculated on area basis, whichever is less.

(9) The owner may take free of charge 200 cartloads of firewood and 100 cubic feet of timber in the round *per annum* provided no deviation from the working plan or interference with rights allowed under the forest settlement is involved.

If he wants more, the value of the excess shall be charged against the owner and debited to his account.

(10) The owner or any persons authorised by him in writing will retain the rights of shooting.

(11) The owner may build *bandhs* inside the forest for irrigating land outside.

(12) Tusks and bones of dead or killed elephants in the forest belong to the owner.

(13) The owner to retain right to quarry and mine under control of the Forest Department.

A note about the revenue and expenditure for the two last financial years will interest the reader:

In 1937-38, the total area under management of the Dhalbhum Forest Division was 180.3 square miles of which 165.9 square miles of reserved forest belonged to Dhalbhum Estate and 14.4 square miles was Estate-owned protected forest in Manbhum District. All common expenditure was apportioned in the ratio of areas, except the cost on account of the pay and T.A. of the Divisional Forest Officer and cost of demarcation which was borne entirely by Government.

	Rs.
Total revenue for the year 1937-38 credited to Dhalbhum forest	12,159
Total expenditure for the year debited to Dhalbhum forest	19,734
The actual total expenditure, however, was ...	28,118

For the year 1938-39 the corresponding figures are:

Area under management:

Belonging to Dhalbhum Estate:

Reserved forest ...	165.9 square miles.
Protected forest ...	22.1 square miles.
Total ...	188.0 square miles.

State-owned:

Protected forest ...	14.4 square miles.

	Rs.
Total revenue credited to Dhalbhum forest ...	15,515
Total expenditure debited to Dhalbhum forest	20,775
Total actual expenditure, however, was ...	29,065

It will be noticed from the foregoing that the terms are very liberal for the owner of Dhalbhum forest. From the 1st April, 1941, he will be receiving a rental of Rs. 7,525 (calculated on 188 square miles of forest, but large areas of forest are still under forest settlement so the amount of rental will increase). In addition, for his purpose, there is expected shortly to be profit which he will share. So much sustained income he could never have obtained if the forests had remained over in his hands; in a few years there would be no forests at all. Government, however, will continue to incur loss over the management for some time. But this was a necessary sacrifice for the salvage of the wrecks of Dhalbhum in the broader and higher interests of the country. In course of time, however, it is certain that the Dhalbhum forests will pay handsomely.

HONAVAR RANGE AND TEAK REGENERATION

BY S. S. DHARESHWAR,

Range Forest Officer, Honavar

PART II

(The previous article appeared in the "Indian Forester," July, 1939)

The statistics given in the appended tabular forms tend to support the view as held in paragraph 7 of the previous article that an espacement of nine feet by nine feet would suit the localities best fitted to teak regeneration here. A test-plot measuring one acre in an uneven-aged crop of almost pure teak in Coupe 12—Block XVI of Balemet, under felling this year, was selected for the purpose. The heights were measured after felling the trees and the actual yield recorded on further conversion of the trees. The logs have been prepared in the round as they are preferred so in the Bombay and Kathiawar markets. The girth measurements have been recorded of logs trimmed of bark. The contractor's profit has not been calculated herein as the test-plot does not represent an average acre of the stand. Teak distribution is varied in the coupe. Therefore, the data as such would be helpful in forming an estimate of the growth and yield in a typical pure natural teak crop.

The natural process of elimination of the weaker stems in the struggle for existence has ultimately left 46 teak stems with a mixture of seven junglewood trees in the understorey. Out of the 46 teak trees, 24 are dominants, mostly free from defects and nine are sub-dominants, 13 being suppressed. Taking the former two classes only as forming the final crop in a teak plantation, the 33 stems conform well to an initial espacement of nine feet by nine feet in an even-aged crop which has had four thinnings as suggested in paragraph 7 of the previous article. The average girth of the dominants is four feet eleven inches or, say five feet, which may have been attained in about 90 years which is in accordance with the data referred to by the writer of the Plan and mentioned in paragraph 4 (iv) of Part I. It is assumed that the average B. H. girth of the 33 stems in a plantation in 90 years would reach five feet. The test-plot has also average soil conditions being situated on the upper-middle slope and not in fertile wash-soil at the foot of the hills. The average stem-timber per dominant is 27.48 or, say 27.50 cubic feet which works out to 907.50 cubic feet of timber for 33 stems in 90 years. The branch-wood timber would amount to 33.66 for 33 stems. This gives an aggregate of nearly 950.0 cubic feet or 76 *khandis* of outturn for one acre. The gross return for an acre of pure teak crop calculated at the rate of Rs. 15 per *khandi* or 12.50 cubic feet delivered F. O. B. Honavar (as now realised by the contractor) for only stem-timber would amount to Rs. 1,089 for 907.50 cubic feet. The branchwood teak and a possible small yield of hardwood fuel is left out of consideration.

As stated above, the coupe contains only sporadic growth of teak as is the characteristic of the species in these parts. The area of the coupe is 59 acres and the value realised in standing sale is Rs. 6,055 which works out an average of about Rs. 103 per acre. A coupe having no teak growth fetches an average of Rs. 24 per acre. This is also the average for the last year's coupe in this block which had no teak in it. Thus the enhanced value per acre in the present case is due to the presence of teak whose yield of stem-timber is about 38 per cent. of the total outturn of hardwood logs. That is, teak occurs in this coupe in a proportion of 6: 10.

The Working Plan aims at conversion of the stand into a mixed deciduous wood containing about 50 per cent. of teak which can

easily quadruple the value of such forests included in its scope. The data in the appended forms show that the locality factors are eminently suited (at least in some of the blocks) even to grow pure teak of marketable size. The yield of stem-timber of the dominants compares favourably with that shown in the outturn table for teak in Begur Range, Wynaad (*vide* Madras Forest Pocket Book) as shown below:

GIRTH CLASS *Feet.*	BEGUR RANGE *Cubic feet*	HONAVAR RANGE (TEST PLOT) *Cubic feet*
3 to 4	10	11.15
4 to 5	18	19.72
5 to 6	28	36.68

The Begur Range timber is squared. Making an allowance of 10 per cent. for squaring the Honavar Range (Testplot) timber, the highest of the three classes would still excel the corresponding class of Wynaad. The figures may not, however, be quite representative but a fair approach to it. There may, thus, be a scope to lengthen the rotation to 90 years as there is a possibility of growing teak of an average size larger than hitherto believed. The enrichment of the forests in general in the congenial localities of a little way inland from the coast, however, depends much upon the popular view which unfortunately at present is biased against teak. This has led to the imposition of rather unfair restrictions on raising teak plantations in Kanara—the home of teak in this part of the country. The sooner the erroneous view is corrected the better will it be in point of promotion of national interests.

STATEMENT I

CLASSIFICATION OF TEAK TREES AND THEIR OUTTURN IN ONE-ACRE TEST PLOT IN UNEVEN-AGED CROP IN COUPE 12, BLOCK XVI OF HONAVAR RANGE, W. D., KANARA.

Class of tree.	No. of Stems.	Girth at D. H. in feet.		Height in feet.		Average Yield in cubic feet per tree.		Total Yield in cubic feet per class		Basal area in square feet per class.	Average distance in feet between stems.	Remarks.
		Average.	Maximum.	Average.	Maximum.	Stem-timber.	Branchwood timber.	Stem.	Branchwood			
1	2	3	4	5	6	7	8	9	10	11	12	13
		ft. in.	ft. in.									
Dominant ..	24	4 11	6 4	83	90	27·48	1·02	59·52	23·48	50·66	30*	*Dominant to dominant.
Sub-dominant ..	9	5 10	8 6	55	60	23·12	3·28	208·08	29·52	26·79	24	Dominant and sub-dominant
Suppressed ..	13	3 3	4 1	32	35	10·86	0·24	141·18	3·12	11·71	16	Average of the plot.
Total ..	46	..	..	..	..	61·46	5·54	1,008·78	56·12	89·16	..	

NOTE.—Average basal area per teak stem=1.9,373 square feet.
Average yield of stem timber per tree=21·93 cubic feet.

STATEMENT II

STATEMENT SHOWING THE BASAL AREA AND OUTTURN OF TEAK IN ONE-FOOT-GIRTH CLASSES IN ONE-ACRE TEST PLOT IN COUPE 12, BLOCK XVI OF HONAVAR RANGE, W. D., KANARA.

Class of tree.	Stems below 36-inch girth		36 to 47 Inches			48 to 59 Inches			60 to 71 Inches			72 to 83 Inches		84 Inches and Above.		Total Stems		Remarks.
	No.	Basal area, square feet.	No.	Volume per stem, cubic feet.	Total basal area, square feet.	No.	Volume per stem, cubic feet.	Tota basal area, square feet.	No.	Volume per stem, cubic feet.	Total basal area, square feet.	No.	Basal area, sq. ft.	No.	Basal area, sq. ft.	No.	Basal area, sq. ft.	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Dominant ..	..	..	4	11·15	4·75	7	19·72	10·68	13	36·68	35·23	..	..	..	..	24	50·66	
Sub-dominant	..	..	..	..	..	4	..	6·66	1	..	2·12	..	..	4	18·01	9	26·79	
Suppressed ..	4	2·33	8	..	8·05	1	..	1·33	..	..	..	..	..	..	..	13	11·71	
Total ..	4	2·33	12	..	12·80	12	..	18·67	14	..	37·35	..	..	4	18·01	46	89·16	

KARNPUR AND BINDRABAN BAMBOO FORESTS

PART II

My Experience of their Management

BY MIAN SAEED AHMAD, FOREST RANGER, PUNJAB

Utilisation of the Produce: Marketing

Bamboos, hardwood timber, firewood and grass are the only products of economic importance. Other things being just sufficient for the satisfaction of rights, bamboo is the only available produce for marketing from these forests.

"Different methods have been tried from time to time for extraction of bamboos in Mukerian Range. Sales of standing coupes, royalty sales and departmental extraction have all been tried and tried from time to time with varying success. Finally in 1918-19, it was decided that departmental operations were the most suitable and the fellings, carriage to Mukerian sale depot and sales continued to be managed departmentally till recently. Under the newly modified arrangements, fellings are carried out departmentally and the sales are effected in the forest depots and the purchasers make their own arrangements for carriage. The disposal of bamboos was also started in 1918-19, but was given up at the end of 1926-27 as it stimulated excessive fellings and necessitated the removal of a large number of dry bomboos to keep the forges going.

"The average cost per cent. on bamboo felling and carriage operations for the period 1921-22 to 1930-31 works out at Rs. 3-1-5 per hundred bamboos; the highest being Rs. 5-9-11 in 1921-22 and the lowest Rs. 2-5-4 in 1926-27. During the same period 5,087,760 bamboos have been marketed at 508,776 bamboos per annum."—*Mohan's Revised Working Plan of Hoshiarpur Division, Vol. I, page* 32.

This procedure of departmental fellings and disposal of raw bamboos by auction or private negotiations *ex*-forest depots continued to be followed up to 1935-36, when for reasons already stated it was found necessary to revert to departmental extraction, conversion, fashioning and then sales as practised from 1918-19 to 1926-27, in order to establish contact with the entire bamboo market and so to be able to work these forests to full advantage. A complete change, however, might have proved drastic and so departmental

work was carried out concurrently with that by purchasers. Canvassing tours were accordingly arranged throughout the Punjab and the N.W.F.P. to receive orders at rates to be fixed by negotiations up to the limit of fixed reserved rates, with bamboos to be delivered *ex*-forest depots or *ex*-Mukerian, raw or fashioned in accordance with the indents registered. Orders were booked on triplicate (printed) indent books which had conditions of sale printed on each indent form. The method worked well except that it invited little competition and was somewhat risky for the canvasser on whom undue pressure could be laid by the purchasers of larger quantities for the reduction of the rates to the absolute minimum, unless, of course, the rates were to be kept fixed for everybody. Therefore once our bamboos had reached every market by two years of personal contact and to the absolute satisfaction of the purchasers throughout, a change to the original and more regular system of sales by auction was considered more suitable and was given effect to from 1938-39. Departmental fashioning was also abandoned as it was found possible to find purchasers for raw bamboos to the extent of the available output. In two years of canvassing sales, from a total sale of approximately 10 lacs bamboos, less than a lac was sold as fashioned. Otherwise, of course, there was nothing of the sort of excessive fellings required to keep the forges going as ample waste stuff was being cut under cleanings to be utilised advantageously for the purpose, and later on this fashioning could have been shifted to Mukerian and firewood arrangements locally made as is done by purchasers, if found necessary. Carriage of bamboos to Mukerian before sale was, however, found favourable because the purchasers' task was thereby rendered easier when they could get their stocks ready at railhead to be taken delivery of at all times, and therefore this was continued and rather extended so as to make all sales *ex*-Mukerian rather than some here and some from the forest depots. The present system is, therefore, to procure bamboos from the forests, cart them raw to the Mukerian sales depot and auction them at short intervals.

The Sources of supply, markets and uses.

The bamboo trade at present is in the hands of a special clan, a community of Shaikhs, mostly belonging to Hoshiarpur and Dasuya in the Hoshiarpur District and some to Jammu in the Kashmir State (those who have settled in Jullundur), who retail in the principal

markets in the Punjab and N.W.F.P. These markets are mainly at Mukerian, Pathankote, Jullundur, Amritsar, Lahore, Hoshiarpur, Sialkot, Rawalpindi and Peshawar; the first 5 in that order assume greater importance. In the Punjab, the sources of supply are the Karnpur and Bindraban forests in the Hoshiarpur District, Bakarrer, Khanni, Talara and Dhamtal forests and Dads Siba and Kutlehr Jagirs in the Kangra District. Bamboos are also imported to the Punjab markets from Bilaspur State, from Shakargarh in the Jammu and Kashmir State and from the Lansdowne Division of the United Provinces, from Lachhiwala, from Najibabad and also from Nagpur and Itarsi in the Central Provinces. The quality of bamboos from each source is, however, different and bamboos from the Karnpur and Bindraban forests are more solid than from anywhere else; for which quality they are well-known. For retail, manufactured (fashioned) bamboos only are in demand except when required for very rough purposes and except for hollow bamboos required by *chick*-makers, etc. (known in the market as *saranchas*).

When departmental operations were taken in hand in these forests from 1918-19 a classification based on the different types of utilisation in the market was arrived at in consultation with the trade and since then this has been adhered to and sales are made accordingly. It is:

Serial No.	Quality	Classes	CLASSIFICATION: Raw as accepted by the middlemen.		CLASSIFICATION: Manufactured as accepted in retail.		REMARKS
			Girth	Length	Girth	Length	
1	*Kalan*	*Salam kalan* I	over 6″	Min. 18′—as long as possible.	Over 6″	18′	In case of raw, classified into two classes only, I and II, based on superiority in shape, straightness and smoothness.
2	,,	Ditto II	Do.	Do.	Do.	16′	
3	,,	Ditto III	..	..	Do.	14′	
4	,,	Ditto IV	..	..	Do.	12′	
5	,,	*Patti kalan salam.*	5½″ to 6″	Min. 18′—as long as possible.	..	..	*Salam* bamboos only sold as raw.
6	,,	*Patti khurd salam.*	5¼″ to 5½″	Do.	..	..	
7	,,	Cut *patti kalan*	5½″ to 6″	In lengths of 9′, 10′, 12′ and 14′	5½″ to 6″	In lengths of 9′, 10′ and 12′, 14′	Obtained by conversion of *patti kalan salam* into cut *pattis* and tops.
8	,,	Cut *patti khurd*	5¼″ to 5½″	7′	5¼″ to 5½″	7′	Obtained by conversion of *patti khurd salam* into cut *pattis* and tops.
9	Special	*Chhar I*	4″ to 5″	22′ and over	4″ to 5″	22′ and over.	Sorted from good *majholas* and *mandhaoos*, very straight, regularly conical and elastic.
10	,,	*Chhar II*	,,	18′ to 22′	,,	18′ to 22′	
11	Average	*Majholas salam.*	4¼″ to 5¼″	15′ to 18′	..	..	*Salam majholas* only sold as raw and converted into cut *majholas* and tops for manufacturing. 6′ and 7′ cut *majholas* are called *khurd majholas* and 9′ and 10′ cut *majholas*, *kalan majholas*. *Salam majholas* can be longer than 18′ when not fit to be classed as *chhars*.
12	,,	Cut *majholas*	,,	In lengths of 6′, 7′, 9′ and 10′.			
13	,,	*Mandhaoos* ..	3¾″ to 4¼″	16′ to 18′	3¾″ to 4¼″	13′ to 18′ also 9′ and 10′	Finer quality converted into 9′ or 10′ long lance staves.

Serial No.	Quality	Classes	Classification				Remarks
			Raw as accepted by the middlemen		*Manufactured as accepted in retail*		
			Girth	Length	Girth	Length	
14	Average	*Lathis*	..	..	$3\frac{3}{4}''$ to $4\frac{1}{4}''$	$5'$ to $6'$	Obtained by conversion of *mandhaoos* into *lathis* and tops.
15	Sotas	*Sota kalan*	$3\frac{1}{2}''$ to $4\frac{1}{4}''$	Min. $12'$	$3\frac{1}{4}''$ to $3\frac{3}{4}''$	Min. $12'$	
16	,,	*Sota khurd*	$2''$ to $3\frac{1}{2}''$	$5'$ to $7\frac{1}{2}'$	$2''$ to $3\frac{1}{2}''$	$5'$ to $7\frac{1}{2}'$	Also converted into $2\frac{1}{2}$ feet long cartmen's sticks locally called *parens*.
17	Miscellaneous	Tops *kalan*	..	$10'$ and over	..	$10'$ and over	Only of *kalan* quality bamboos. Girths may be any in case of all the tops.
18	,,	Tops *khurd*	..	$8'$ to $10'$	..	$8'$ to $10'$	
19	,,	*Majhola* Tops	..	$8'$ and over	..	$8'$ and over	
20	,,	*Mandhaoos tops*	..	,,	..	,,	
21	,,	*Saranchas*	$4''$ to $5''$	$12'$ and over	..	..	Only sold as raw, hollow tops of *patti kalan* and *salam kalan*, hollowness to allow easy splitting. Girth taken at bottom thicker end.

NOTE

Saranchas are sometimes sub-divided into first and second class, the criterion being of length; 12 to 13 feet long goes as II Class and above that as I Class.

Girths are measured in the middle of the third internode from the thicker end, cut internode whose part is with the bamboo being counted as one. In case of *saranchas* the girth is measured at the bottom (thicker end).

In actual practice the minimums in girths of all classes are never placed in their respective classes at the time of fellings, an allowance of $\frac{1}{4}$ inch being given for shrinkage.

In other cases bamboos are only sold as *kalan, doem* or 2nd class, *khurd* and *sotas,* although in actual retail the above classification is followed.

The various classes have their various uses but generally *kalan* quality is used for ladder-poles, tent-poles, tonga-posts, beds and cart sidings. Average quality is used for thatching, roofing, ladder-steps, tent-*kanats, lathis* and lance staves. Special *chhar* quality is used as shepherds' pole with sickle at one end for lopping purposes. Small *sota* quality for small-sized *lathis,* flag-poles, mosquito-net poles, zamindars' walking sticks and cartmen's sticks for driving cattle. In the case of miscellaneous classes, hollow *saranchas* are used for *chick*-making, basket-making, for kites and for bows and arrows and also to be turned into needles to be tied as sweepers' besoms; while tops can be put to any miscellaneous use such as for fixing canal banks, for mosquito-net poles, flag-poles, tent-*kanats,* for thatching small cattle-sheds and for sweepers' besoms too.

Other miscellaneous uses of the various bamboos are: in furniture (cane furniture particularly), for tying rafts, fishing, agricultural and domestic tool handles, tent-pegs, fences, yokes, axles, mats, pipes, umbrella staves, toys, scaffolding and, last but not least, as an important source of cellulose for paper making. The immature *manu* is pickled and can also be eaten as a vegetable. It is thus among the most useful indigenous products: of importance to the people both in the villages and in the towns for a surprisingly wide range of purposes and perhaps it is the only plant which renders so much service to mankind.

EXTRACTION: DETAIL OF VARIOUS OPERATIONS FROM FELLINGS UP TO FASHIONING

(1) *Fellings: Past and Present.*—"The number and class of bamboo to be felled each year from the annual coupe, depending upon the demand which is estimated by small advance sales, is determined by the Divisional Officer. Gangs of coolies working under a mate are allowed in the felling coupe with instructions to bring out a certain number of a certain class of bamboo, from the compartments earmarked for the purpose. The coolies by years of training

and experience know what to cut and what not to cut. They go through the coupe and collect at the forest depots the class of culms ordered. A depot officer, who is generally a forest guard, keeps an account of all the culms brought in day after day. When the desired quantity of the class of bamboo in question is received in the depot, the coolies are stopped from cutting any more of that class and are ordered to cut some other class. Sometimes more is cut than has been sold in advance and this is disposed of by auction. The coolies are paid by the Department on contract rates according to the class of bamboos cut."—*Deogan, Indian Forest Records, Vol. II, No.* 4.

The above is a précis of the past practice. But now fellings start in October and cleanings are done at the same time. The work is done by a special type of bill-hook known as *drat* and the coolies have to work every clump in the coupe under regular instructions and supervision. By experience they know the distinction between culms of different ages roughly recognised as under. (Plate 16 shows the work as now done.)

"(*a*) New or one-season-old culm (*manu*) has fresh-looking bracts on nodes and a coating of white waxy bloom on internodes which comes off with the lightest touch; it usually has few or no branches.

(*b*) Two-season-old culms may still retain the bracts in certain localities, but if so they are withered and darkish in colour, sometimes erect and sometimes hanging on to the nodes. The internodes are greenish in colour with a thin bloom spread fairly uniformly, though thicker near the nodes; it comes off when a finger is lightly rubbed over it. Side branches are present on the nodes.

(*c*) Three-season-old culms generally have no bracts, but if any remain they are discoloured and weatherworn and prevented from falling by some obstruction. The bloom is no longer uniform but is variegated by darker blotches and is not readily removed by rubbing.

Typical of present working practice. R. F., Karnpur, area worked in 1936-37.
Forest Ranger Saeed Ahmad (the Range Officer) standing.
Photo by courtesy: Mr. J. N. Sen-Gupta, E.A.C.F. 16-5-38.

(*d*) Four-season-old culms are green with little or no bloom. On cool sides there are generally big dark blotches on the surface of internodes which can be rubbed off easily.

(*e*) Still older culms show yellow patches in the green. They are a sure sign for full maturity."—*Deogan, Indian Forest Records, Vol. II, No.* 4.

In actual practice it is generally difficult to distinguish between culms when they are 3 years or more old unless overmature. The fellings are governed by the rules detailed already and normally a spacing of nine inches between individual culms is given. The distribution of culms older than 2 seasons in the clumps is based on their availability and the coolies start their removal, after cutting the waste stuff, by cutting the oldest culms and working up to the permissible minimum of age, subject to the normal spacement mentioned above. *Manus*, where available under thinnings, are cut only if required for tying bamboo bundles and mostly malformed *manus* are utilised as such.

They then classify the different bamboos cut simultaneously with the fellings by a rule of thumb, arrived at by experience and practice, and bundle up different classes separately directly in the forest; *salam kalan* and *khurd* and *kalan salam pattis* in bundles of 5, *majholas* and *chhars* in bundles of 10, *mandhaoos* in bundles of 15, *sotas kalan* in bundles of 20 and *sotas khurd* in bundles of 40 each. *Manus*, or culms of the previous year, are used for bundling purposes after splitting except their interior pith; such a culm can be used to tie at least 5 bundles with 3 bunds in each. These bundles are then carried to the forest depots (the same coolies do this on their shoulders) where they are checked by the depot guard and stacked in convenient heaps by classes. The daily record of fellings is entered up in Depot Form 5, and a daily register record of each coolie's work is separately maintained for purposes of accounting. In practice, coolies work in groups of 2, 3 and even 4, but they distribute their outturn at the end of the day's work before recording. They are paid on a contract basis, according to the class of saleable

bamboos procured, the rate covering operations from fellings and cleanings up to stacking in the forest depots. The rates paid are:

Serial No.	Class.	Rates Paid Per Cent.			Remarks.
		For fellings alone	For cleanings alone.	Total for cleanings and fellings.	
		Rs. a. p.	Rs. a. p.	Rs. a. p.	
1	*Salam kalan* ..	2 4 0	0 6 0	2 10 0	1. Mate commission paid for procuring labour day by day per hundred bamboos cut and stacked by labour —0-0-6.
2	*Patti kalan salam* ..	1 10 0	0 6 0	2 0 0	
3	*Patti khurd salam* ..	1 7 0	0 4 0	1 11 0	
4	*Chhar I* ..	1 8 0	0 4 0	1 12 0	
5	*Chhar II* ..	0 15 0	0 4 0	1 3 0	
6	*Majholas salam* ..	0 15 0	0 4 0	1 3 0	
7	*Mandhaoos* ..	0 11 0	0 3 0	0 14 0	2. Labour supplied free drinking water in work:
8	*Sota kalan* ..	0 9 0	0 3 0	0 12 0	
9	*Sota khurd* ..	0 4 0	0 2 0	0 6 0	In Karnpur at 0-0-10 per tinful.
10	Cut *patti kalan* ..	0 13 0	0 2 0	0 15 0	
11	Cut *patti khurd* ..	0 11 6	0 0 6	0 12 0	Only if procured from top broken bamboos.

The coolies receive their wages monthly and on an average earn from 0-7-0 to 0-8-0 per day.

2. *Carriage.*—The only line of export from these forests is the *katcha* road leading from Mukerian to Talwara, joined up by cart tracks running in the forests along the beds of *nalas*, and the possible means of export is only carts. The present system is that tenders are invited every September and a carriage contractor is engaged. The bamboos are loaded by the cartmen from the forest depots and are carted to the Mukerian Sales Depot where these are unloaded again and stacked in convenient lots separately by classes. Every loaded cart that leaves the forest depots is given a duplicate *challan* with entries of bamboos being carted. Of this one copy is handed over to the Mukerian Depot guard for his check and return, acknowledging the receipt of bamboos to ultimately form the basis of the contractor's claim to his dues, and the other copy remains with

the cartman who claims his wages from the contractor through it. The distance of this carriage from the forest depots to the Sales Depot varies from 14 to 18 miles, and the following rates are paid inclusive of loading and unloading charges:

Serial No.	Class	Carriage Rate per 100 Rs. a. p.	Remarks
1	*Salam kalan* ..	3 4 0	These rates are in force in 1939-40, and there is only slight variation from year to year.
2	*Patti kalan salam* ..	2 4 0	
3	*Patti khurd salam* ..	2 1 0	
4	Cut *patti kalan* ..	1 8 0	
5	Cut *patti khurd* ..	1 0 0	
6	*Chhar* I ..	2 0 0	
7	*Chhar* II	1 14 0	
8	*Majholas salam* ..	1 11 0	
9	*Mandhaoos*	1 1 0	
10	*Sota kalan*	0 10 0	
11	*Sota khurd*	0 5 0	
12	*Saranchas*	1 0 0	
13	Tops *kalan*	0 14 0	
14	Tops *khurd*	0 10 0	

In addition to the above rates the contractor is paid a commission of 0-3-0 per cart loaded, at the end of the season, if the work is done satisfactorily. Also, a further rate of 0-2-0 per cartload is paid to him for the stacking he does in the Sales Depot after unloading.

Previous to our undertaking departmental carriage, *i.e.*, when purchasers used to make their own arrangements, bamboos used also to be carted directly from forest depots to the purchasers' depots at Dasuya, Hoshiarpur, Jullundur, Kapurthala, and even Amritsar. For other places carriage was done by carts up to Mukerian and onwards by rail. Bamboos meant for Kapurthala and Amritsar used also to follow this route when direct cartage could not be arranged by the purchasers.

A cart on an average can cart 300 bamboos with all classes, viz., *kalan*, average and small, etc., represented in a load, but when absolutely freshly cut hardly 250 go in it. The cartmen generally shirk to load bamboos cut less than about a fortnight before carriage. The following quantities of different classes may constitute a cart-load with 4 bullocks to pull and weighing approximately 35 maunds:

Salam kalan	100
Patti kalan salam	150
Patti khurd salam	200
Majholas	300
Mandhaoos	450
Chhar I	200
Chhar II	220
Sota kalan	600
Sota khurd	1,200

An average 4-wheel wagon can carry approximately 4,000 raw bamboos but in view of the length of bamboos the special type E.B. wagons with side windows are mostly used which the purchasers make special arrangements to obtain.

Transport of bamboos from these forests during the hot weather and rains is almost impossible, the former because of severe heat and lack of water either for man or for cattle and the latter because the roadway is mostly clay and the road surface lower than the country around, so that heavy rains render it impassable.

3. *Sales.*—Sales are now made at Mukerian by open auction and the statement below gives an idea of the fluctuation in prices from year to year beginning from 1935-36 to 1938-39:

Serial No.	Class	Average Rate Realised Per Cent for Raw Bamboos ex-Mukerian.				Quantity sold in 1938-39.	Remarks
		1935-36	1936-37	1937-38	1938-39		
1	*Salam kalan* ..	..	18 2 0	18 4 0	35 13 4	120	
2	*Patti kalan salam*	10 12 0	11 2 0	11 12 0	18 8 7	3,755	
3	*Patti khurd salam*	9 0 0	8 14 0	9 2 0	12 3 10	26,525	(1) Sales in 1935-36 were made by open auctions, in 1936-37 and 1937-38 by negotiations in canvassing tour and again in 1938-39 by open auctions.
4	Cut *patti kalan* 10′ ..	10 8 0	8 1 0	..	13 13 1	2,200	
5	Cut *patti khurd* 7′ ..	..	6 5 0	..	10 1 9	900	
6	*Chhar* I ..	10 14 0	11 8 6	11 10 0	12 5 6	11,600	
7	*Chhar* II ..	..	8 6 0	8 6 0	9 12 7	1,400	
8	*Majholas salam*	4 12 0	4 14 9	5 1 0	4 10 9	219,900	(2) *Saranchas* are only sold to the Jail Department at fixed rates.
9	*Mandhaoos* ..	3 9 0	3 7 3	3 8 0	2 5 0	107,625	
10	*Sota kalan* ..	2 2 0	2 5 9	2 7 0	1 14 2	62,350	(3) The quantities of different classes sold in 1938-39 represent the average proportion of each class of bamboos available from a year's coupe.
11	*Sota khurd* ..	1 14 0	1 14 0	1 13 6	1 13 10	57,640	
12	Tops *kalan* ..	..	..	..	5 8 7	650	
13	Tops *khurd* ..	..	1 12 0	..	1 12 0	2,800	
14	*Majhola khurds*	..	..	..	4 0 0	2,800	
15	*Saranchas* ..	9 12 0	8 14 0	..	10 0 0	2,450	

4. *Manufacturing.*—The demand in the actual retail market is for fashioned bamboos only. Manufacturing is a crude process and the raw bamboos to be manufactured are first converted into various sizes and their knots are dressed to give them a smooth surface, after which they are heated in a furnace and then straightened by bending through holes cut in wooden posts fixed in the ground alongside the furnaces and inclined to the opposite side of the workman. Heating renders the fibres elastic and alternate heating and bending removes the bends, etc., that may be in a bamboo

in addition to the dark-brownish colour imparted. The fibres stay as thus displaced, rendering the originally bent bamboos straight. Thinner bamboos or special bamboos of the type of lance staves, thin ends of the *chhar* class, small-sized *sotas*, etc., are straightened by a crude wooden instrument called *takash* which is just a piece of wood with a curved U-shape cut at one end for accommodating the bamboo to be straightened after the usual heating. After dressing, bamboos are usually spread out with a view to having them slightly seasoned before subjection to to the manufacturing process. Some qualities such as *lathis* are also sometimes given a wash with an attractive colour mixed in oil before fashioning.

Fashioning is one of the most difficult jobs to do and requires not only hard labour and skill from the workmen but also organisation and tact from the employer. There is a special clan, particularly from Pathankot, Batala and Gujrat, known as *kamagars* or *kamangars,* who are well versed in it. The following are the rates generally paid to them in the market. These were also the rates paid to this labour by the Department when the departmental work was done in 1936-37 and 1937-38:

Serial No.	Class	Fashioning, per cent.			Dressing, per cent.			Cutting to proper sizes with saw, per cent.			Approximate cost of fuel, per cent.			
		Rs.	a.	p.	Rs.	a.	p.	Rs.	a.	p.	Rs.	a.	p.	
1	*Salam kalan* I ..	4	8	0	0	8	0	0	3	0	1	8	0	
2	Ditto II ..	4	0	0	0	8	0	0	3	0	1	8	0	
3	Ditto III ..	3	0	0	0	8	0	0	3	0	1	4	0	Same rates paid for 14-foot and 12-foot *pattis*.
4	Ditto IV ..	2	8	0	0	6	0	0	3	0	1	0	0	
5	Cut *patti kalan* 9 to 10 feet ..	1	8	0	0	4	0	0	3	0	0	12	0	
6	Cut *patti khurd* 7 feet	1	0	0	0	3	0	0	3	0	0	10	0	
7	*Chhar* I ..	4	0	0	0	10	0		..		1	8	0	
8	*Chhar* II ..	2	8	0	0	8	0		..		1	4	0	
9	*Majhola kalan* ..	1	4	0	0	4	0	0	3	0	0	12	0	
10	*Majhola khurd* ..	0	12	0	0	3	0	0	3	0	0	10	0	
11	*Mandhaoos* ..	1	8	0	0	5	0		..		1	0	0	
12	*Sota kalan* ..	1	4	0	0	3	0		..		1	0	0	
13	*Sota khurd* ..	0	12	0	0	2	6		..		0	8	0	
14	*Lathis* ..	0	10	0	0	3	0	0	3	0	0	10	0	
15	Tops ..	0	12	0	0	3	0		..		0	8	0	

In addition to these rates, the Department paid a commission of Rs. 2 per thousand bamboos manufactured to the mate who arranged the supply of labour and each workman was supplied one tinful of water per day at Government expense at annas 10 per tin in Karnpur and 0-1-3 per tin in Bindraban. To these rates has been added a column giving approximate cost of fuel utilised for each class.

A dresser can dress up to 400 bamboos per day and a *mistri* can fashion up to 100 bamboos per day on an average. The dressers generally earn from annas ten to twelve per day and *mistries* from Rs. 2 to 3 per day. They work only for 9 months in a year and have generally to spend the 3 months of monsoons without work.

Before closing, an idea of the bamboo trade at Lahore will give the position of the bamboo dealers and the statement following has been compiled with their consultation and is believed to be correct:

STATEMENT SHOWING POSITION OF BAMBOO TRADE AT LAHORE IN 1938-39 PER 100 BAMBOOS

Serial No.	Class of Bamboos	Prices paid to Government in 1938-39	Carriage to Railway Station at Mukerian	Loading Charges	Terminal Tax	Freight	Unloading at Lahore	Carriage to Shops	Octroi Duty at Lahore	Manufacturing, Dressing charges including Re-bundling and Cost of Fuel, etc.	Incidental Charges	Total Expenditure	Rate of Sale at Lahore	Profit
		Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.
1	*Salam kalan* ..	35 13 4	0 4 0	0 8 0	0 4 6	4 12 6	0 2 0	1 0 0	1 0 0	8 14 0	1 0 0	53 10 4	57 0 0	3 5 8
2	*Patti kalan* cut	18 8 7	0 2 0	0 2 0	0 2 0	2 2 0	0 1 0	0 8 0	0 8 0	3 7 0	0 8 0	26 0 7	29 0 0	2 15 5
3	*Patti khurd* cut	12 3 10	0 2 0	0 1 6	0 1 6	1 9 6	0 0 9	0 6 0	0 6 0	2 5 0	0 6 0	17 7 1	20 0 0	2 8 11
4	*Majhola* ..	4 10 9	0 2 0	0 2 0	0 2 0	2 2 0	0 1 0	0 8 0	0 8 0	4 3 0	0 8 0	12 14 9	15 0 0	2 1 3
5	*Mandhaoo* ..	2 5 0	0 2 0	0 1 6	0 1 6	1 9 6	0 0 9	0 6 0	0 6 0	3 5 0	0 6 0	8 11 3	10 0 0	1 4 9
6	*Chhar* I ..	12 5 6	0 2 0	0 2 0	0 2 0	2 2 0	0 1 0	0 8 0	0 8 0	8 13 0	0 8 0	25 3 6	30 0 0	4 12 6
7	*Chhar* II ..	9 12 7	0 2 0	0 2 0	0 2 0	1 9 6	0 0 9	0 6 0	0 6 0	6 10 0	0 6 0	19 8 10	22 0 0	2 7 2
8	*Sota kalan* ..	1 14 2	0 1 0	0 1 0	0 1 0	1 1 0	0 0 6	0 4 0	0 4 0	3 2 0	0 5 0	7 1 8	8 2 0	0 14 4
9	*Sota khurd* ..	1 13 10	0 0 6	0 0 6	0 0 6	0 8 6	0 0 3	0 2 0	0 2 0	2 4 0	0 2 6	5 2 7	5 8 0	0 5 5
10	Tops I ..	5 8 7	0 1 0	0 1 0	0 1 0	1 1 0	0 0 6	0 4 0	0 4 0	3 2 0	0 5 0	10 12 1	11 0 0	0 3 11
11	Tops II ..	1 12 7	0 1 0	0 1 0	0 1 0	1 1 0	0 0 6	0 4 0	0 4 0	2 6 0	0 5 0	6 4 1	6 8 0	0 3 11

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THE ROLE OF CHEMISTRY IN FORESTRY

PART IV

BY DR. S. KRISHNA

Presidential Address at the Twenty-seventh Indian Science Congress.

India abounds in innumerable medicinal plants and herbs which have, from time immemorial, been used in the indigenous system of medicine. But to-day, on account of the popularity of the allopathic system, most of these drugs do not find sufficient recognition, and consequently, enormous quantities of medicinal preparations have to be imported. In 1908 09, the import of drugs (excluding chemicals and narcotics) was valued at Rs. 73 lakhs and this, in nearly 30 years, has increased to Rs. 207 lakhs including proprietary medicines worth Rs. 68 lakhs. The enormous increase in the consumption of patent medicines, of foreign origin, is particularly noteworthy.

Many of the herbs that yield the imported pharmacopœial preparations are available in India but these too are not being exploited to any extent because correct knowledge regarding their potency, active constituents and pharmacology is still lacking. Research, both chemical and pharmacological, is therefore necessary to get recognition for these indigenous drugs before development of trade may be expected. There are, however, some drugs which have been recognised by various European and American pharmacopœias and are in demand, but the bulk of these are being exported as raw drugs and their extraction, medicinal preparation, and standardisation in India, is being done only to a limited extent. The total value of drugs and medicines, manufactured in India, at the present time, may possibly be in the neighbourhood of Rs. 50 lakhs. This figure would appear satisfactory considering that about 30 years ago, the manufacture of drugs in India was practically nil, and yet, in comparison to Rs. 207 lakhs, the value of imported medicines, this becomes insignificant. The manufacture of drugs in India which is being conducted on a small scale is capable of expansion, at least in the case of those raw drugs which are now being exported and such an effort would prove satisfactory from many points of view, besides effecting a considerable saving in freight charges on

bulky crude drugs. The export of raw drugs in 1908-09 was worth Rs. 15 lakhs but this during the post-war boom (1928-29) rose to over 40 lakhs and since then, has been steadily declining. One of the reasons for this might be the tendency to adulterate commercial products which is a common failing in this country and owing to which many valuable trade connections have been lost. This practice could be entirely eliminated if the crude drugs were to be worked up into finished medicinal preparations, in India. Furthermore, the margin of profit would be higher and it would be possible to compete with medicinal products from other countries, both in the home and foreign markets.

To illustrate the point, the case of the herb ephedra may be cited. Up till 1928, China held the monopoly of supply but due to the disturbed political conditions, supplies became both irregular and scanty and prices rose considerably; the drugs being in great demand as a remedy for asthma and hay fever. This led to interest being taken in Indian ephedras. This interest, however, did not last long and, for reasons not fully understood, ceased rather abruptly. Probably the supplies accepted during the period of shortage were not of the standard quality. In any case, the fact remains that India failed to establish ephedra in the markets of Europe and particularly of U.S.A. which is the greatest consumer of this drug. Since July, 1937, owing to wars in China and Spain (another supplier) the interest in Indian ephedra has once again revived and in 1938 U.S.A. purchased nearly ½ million pounds, but China, on resuming her exports to U.S.A., is steadily ousting Indian ephedra once more. The uncertainty of the quality is perhaps one of the chief reasons for this state of affairs. If the drug could be extracted and ephedrine or its salts could be placed on the U.S.A. markets this uncertainty regarding the quality of the products would vanish and there would be no possible reason why these would not sell and compete successfully with the Chinese product. The case of ephedra is not an isolated one. Almost every drug has suffered more or less the same fate unless it has so happened that India has held its monopoly. Even in the case of drugs in which India has held the world monopoly it has not been possible to maintain the position and sooner or later competitors have sprung up who have marketed the same product, better in quality

and cheaper in price. For example, India at one time, held the monopoly of trade in *Strychnos Nux-vomica* but the same cannot be said of her to-day. She is meeting serious competition from Indo-China and Ceylon, although about two-third of the commercial supply of the seeds is still in her hands. Even this advantageous position may not be retained for long unless the questions of collection, sorting, storage, etc., are properly looked into by the Forest Department. The Forest Department earns Rs. 60,000 per annum in royalties from *Nux-vomica,* hence they ought to be able to meet the necessary expenditure involved in bettering the conditions of trade in this important drug. Of about 80,000 cwt. of seeds available every year more than 80 per cent. are exported and the balance is utilised in the country for extraction of the alkaloids. Strychnine is one of the most important drugs in present-day medicine and in spite of the large amounts of the raw material being available, only a little interest has been shown in its utilisation in this country. The value of strychnine to the raw material is almost as 30: 1 and much financial gain would, therefore, result if the manufactured material were to be exported instead of the raw drug.[28]

Similarly, artemisia is another raw drug which is being largely exported. The export of *Artemisia maritima* and *Artemisia brevifolia* now nears 150 tons a year whereas only about one-third of this quantity is utilised for the extraction of santonin in India. The average santonin content of these artemisias is about 1 per cent. so that large sums of money, now spent on freight of the crude drug, could be saved if santonin was to be exported. Furthermore, this procedure would give it better chances to compete successfully in the world markets. Russian Turkestan had, at one time, held the monopoly of supply of santonin and consequently could keep the level of prices very high. But since the entry of Indian artemisia and santonin in the world markets, prices have steadily declined. Thus, the monopoly of Russian Turkestan may be said to have been broken and the position of Indian artemisia fairly established in the world markets.

There are many other drugs, which are found in abundance but most of them are exported in crude form, very little being extracted in the country. Belladona, Hyoscymus, Podophyllum, Aconites, Juniper, Valeriana and many essential oils are a few of

the raw products which could be converted into medicinal preparations. Economic advantages to be gained from such attempts are obvious and need no elaboration, particularly for those herbs that grow plentifully in the country and are of established pharmacopœial application.

India possesses a variety of soils and climates and, therefore, could easily cultivate and acclimatise a variety of herbs and plants of economic value. For example, *Chrysanthemum cinerarifolium* (Pyrethrum) and *Derris elliptica* or *D. malaccensis,* which during the past 15 years have acquired a position of great importance as plant insecticides, could be cultivated and acclimatised in India, even though they are not indigenous to this country. Pyrethrum was introduced in Kenya a few years ago, where it has done remarkably well. India possesses climate and soil comparable to that of Kenya and there is no reason why its cultivation should not succeed here. In fact, the experimental cultivation of pyrethrum, in the Murree Hills and Kangra valley,[29] has already shown good promise. Similarly *Derris elliptica* and *D. malaccensis* of Malaya and Java, which form the main bulk of commercial derris could easily be introduced and cultivated here even though they are not indigenous to India and would undoubtedly get acclimatised specially as other derris species are known to occur in India. These other species of derris, however, do not contain rotenone and allied toxic principles except *D. ferruginea* which is found to grow wild in certain parts of Assam.[30] The use of derris has increased enormously and has replaced the mineral preparations (arsenicals and lead salts) which were popular as insecticides, at one time. This is due to the fact that derris is poisonous to insects and cold-blooded animals only and is practically harmless to cattle and human beings. U.S.A. alone is importing several million dollars worth of derris and this has consequently stimulated its cultivation in many countries.[31]

Originally, derris used to be employed as a fish poison and its use as a vegetable insecticide is of recent origin. There are many more species of plants which, like derris, are reputed as fish poisons and chemical examination of some of these for insecticidal constituents, has led to rotenone being isolated from such species as *Milletia pachycarpa* and *Tephrosia candida*.[32] These findings are of great value to India because the Indian agriculturists, although

they suffer considerable loss of crop through ravages of insect pests, are too poor to pay for the costly insecticides imported from foreign countries. If indigenous vegetable insecticides could be placed in their hands at low cost or they could be encouraged to cultivate them, they would readily employ the same to save their crops. It may be stated, in this connection that the discovery of rotenone in *Tephrosia candida* root bark and seeds is of particular value because this species is often grown round the fields and utilised as green manure. Advantages to be gained by the use of such insecticides, in a vast agricultural country like India, are, therefore, enormous.

It would appear, from what has been stated before, that the condition of the drug trade in India is unsatisfactory and that the systems of marketing, collection, manufacture, etc., all need careful looking into. The following extract from the Drug Enquiry Report (p. 277) will lend support to the view: "Although indigenous raw materials of drug manufacture are available in India, there are no reliable dealers with expert knowledge for such articles. Generally, indigenous drugs are supplied by small private collectors, who personally, or through their agents, collect the drugs from the forests and offer them for sale at provincial towns. A manufacturer invariably finds it difficult to depend upon the potency of a drug even when supplies come from an authoritative source. For instance, digitalis supplied by the Government plantations and sometimes by the Forest Department of the Kashmir State proved physiologically inactive after extraction. The reason possibly is that drug collection is not done with care and prudence." In India, only medicinal plants and herbs, which grow wild, have so far been collected and utilised. Further they are collected by ignorant people and are prepared for the market without paying any special attention, which may be necessary to prevent the destruction and decomposition of the active principles. This, along with the tendency to adulterate, has lowered the trade position so far that crude drugs of Indian origin have come to be regarded as unreliable. These, certainly, are positive difficulties in the way of manufacture of the drug in India and can only be remedied if a regular supply of genuine raw materials of the proper quality is assured.

As a natural corollary to the above, it would appear that the solution of the trouble lies in the cultivation of drugs, thereby making the consumers independent of the supplies from unreliable sources. Cultivation of drugs as the panacea of all ills may appear to be quite a simple solution but, in reality, it too is attended with many difficulties which, however, are not insurmountable. Questions that arise in this connection are: Is it possible to improve the active constituent of a wild drug by cultivation? What to cultivate and where? Will it be profitable to undertake cultivation of medicinal plants? Complete and correct answers to such questions, however, are not easily forthcoming because of the fact that there is practically no information available in India regarding cultivation of medicinal plants, carried out on right lines by any expert body. Cinchona cultivation is perhaps the only exception. In this case, too, the cultivation has not really been conducted on thoroughly scientific lines, with the result that the quinine content (under 5 per cent.) of Indian cinchona is markedly below that which has been obtained in other countries. Java, for example, by intensive cultivation, has been able to raise the quinine content to 8 per cent. and in some plantations a content as high as 11 per cent. is also reported.[33] In cultivation of cinchona India has an experience of nearly 50 years but the results hitherto achieved are really not as satisfactory as they should have been.

Even though information is incomplete on the question of improving the active constituent of medicinal plants by proper care and cultivation, yet the results achieved by some workers elsewhere give clear indication that success is possible in this direction. The experimental data and experience available for improving the yield and quality of the usual agricultural crops seem to be not of much help in the cultivation of medicinal plants. The question is far more complicated because the word "quality" in the case of medicinal plants has not the identical meaning when it is applied to other economic plants. In the case of medicinal plants it is not limited to obtaining the maximum yield per acre but encircles a wide chemical field aiming at the improvement of individual constituents of importance such as alkaloids, glucosides, bitter principles, essential oils, etc. Valuable results can be obtained by acclimatisation, choice of

species, selection and breeding, proper manuring and in general by securing the most favourable cultural conditions. The case of cinchona and that of *Vetiveria zizanoides* has already been cited where by cultivation the principal constituent has been markedly increased. Another interesting case is that of *Derris*, in which the rotenone content has been raised to over 10 per cent. *Datura strammonium, Atropa belladona, Hyoscymus niger, Digitalis purpurea* and many others have been shown to respond well to manurial and cultural treatments and yield higher quantities of active constituents. But much work still remains to be done before establishing the specific measure which will guarantee the maximum quantity of the active constituent.

It may be mentioned here that in many of the foreign countries great interest is being taken in the cultivation of medicinal plants with a view to making them self-sufficient in the supply of crude drugs. To encourage the cultivation of such plants in India, the question will have to be considered in several aspects. For instance, answers to questions like supply of full technical data regarding the kind of plants and herbs that could be successfully cultivated in a given locality, whether they should be cultivated under irrigation or as dry crops, whether there is a definite demand and a steady price for such drugs, whether such crops should be grown in preference to normal agricultural products, whether supply of seeds and technical assistance would be available and also answers to many related problems will have to be obtained if cultivation of medicinal plants is to be seriously undertaken. In India, very scanty data, if any, is available on these subjects. In foreign countries such work is taken up by private organisations having the support of their respective governments. In Belgium, the cultivation of medicinal herbs and essential oil bearing plants is dealt with by an association consisting of professors, doctors, pharmacists, botanists, representatives of trade and landowners. This association is connected with the Ministry of Agriculture and deals with cultivation, manuring, breeding, acclimatisation and the general fostering of scientific study of all medicinal plants. Such organisations also exist in Holland, Germany (National Working Association for Medicinal Plant Lore and Study), Italy (The Experi-

mental Station for Medicinal Plants, Naples), Lithuania (Lithuanian Drug Society), Hungary (Royal Hungarian Experiment Station for Medicinal Plants) and in Poland (Polish Medicinal Plant Committee). The Polish Committee acts in an advisory capacity to the growers and exerts its influence on production. It receives information as to the areas under cultivation, yields and stocks and by agreement with a trade commission fixes prices of crude drugs and publishes them in the monthly journal "Wiadomosa Zielarski" (Herbal News). Valuable services have been rendered by such organisations in stimulating the cultivation and improving the quality of drugs and the general standard of trade in their respective countries. It would perhaps be advantageous if such an association were to be formed in India also. The question of the cultivation of drugs is an important matter and it is primarily the concern of the Agriculture Department in the provinces to collect all the available information on the subject, explore possibilities and conduct actual experiments. Even if a start were to be made immediately, it will be a long time before they would be in a position to disseminate the knowledge gained to the agriculturists. The Forest Department can also render valuable help in this direction, and as a practical step the Forest Rangers and Guards could take up cultivation of those drugs which are commonly found in their localities and of which they very often possess a sound knowledge. The experience gained from these experimental cultivations could, at a later stage, be helpful in taking up commercial cultivation of medicinal plants.

(Concluded.)

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REVIEWS AND ABSTRACTS

THE TRAVANCORE TRIBES AND CASTES

VOLUME II

By Mr. L. A. Krishna Iyer.

A copy of the above lies before us. (Volume I was not received in this office.)

The volume in question has a good introduction to the public for Dr. J. H. Hutton of Cambridge provides a foreword and Baron Egon von Eickstedt of Breslau has written a lengthy introduction. The latter is concerned with the scientific nomenclature of *Homo sapiens.* Let all those who rail against botanical or entomological nomenclature thank their lucky stars that they have nought to do with anthropology. *Homo sapiens indicus indobrachimorphus* is simply a Bengali and *Homo sapiens veddalis gondicus* a Gond!!! Binomial nomenclature fades into insignificance in comparison with these sonorous appellations.

The author tells us in his preface that he was placed on special duty in 1937 to complete the ethnographic survey of the State. One volume of the results of his labours was produced in 1938, the present volume in 1939, and we are promised a third volume in 1940.

The second volume gives an interesting account of eight of the aboriginal tribes of Travancore. Each tribe is treated in a systematic manner according to a definite plan, and a wealth of interesting matter is provided for the reader. The volume is profusely illustrated with plates, which are reasonably well reproduced from photographs taken by the author.

The Government of Travancore are to be congratulated on their enterprise and the complete set of volumes should be of great value to every officer who has anything to do with the administration of the State. *Homo sapiens humilis sylvaticus.*

EXTRACTS

INDUSTRIAL CHARCOAL

Industry absorbs many materials, mostly in their raw state, but quite a number have to undergo a preliminary process of manufacture before they are in a fit state to be so used. Naturally enough constant investigation is taking place so as to simplify or modify the preliminary processes involved to facilitate as much as possible the production of the materials needed. Amongst the many materials undergoing investigation is also our old friend, Charcoal. Now in this country perhaps we are much more familiar with the commoner uses of charcoal than people in a good many other countries. We see it here being used in crude form almost at every street corner, while other countries are more concerned with the industrial uses to which this material can be applied. The way of obtaining quantities of charcoal will be familiar to many. It is worth mentioning, however, that there are various kinds of charcoal, depending on the material from which it is produced. It can be obtained from wood, bone, coal and also sugar. To be used as a fuel, it is best obtained from the partial combustion of wood. It should be noted that wood charcoal is not only used as a fuel but also as a polish, a filter and as an absorbent of gases and vapours. Since it is a non-conductor of heat, its use extends to the preparation of cold storage and refrigeration, as packing. But there is also animal charcoal, produced by the dry distillation of bones and ivory. These do not exhaust all the sources of supply, but they are the main sources.

The quality of charcoal produced varies a good deal. For certain industrial purposes only the best can be used, so in the majority of cases quantity must also be accompanied by maximum quality. As one would expect, considerable attention is being paid to this by research students, and appropriately enough by those connected with forestry research. There recently appeared in England a periodical report of the Forestry Products Research Board and, amongst the activities discussed therein, the manufacture of charcoal for industrial purposes finds a place. The object was to investigate means of producing the highest quality charcoal in *portable kilns*, to facilitate the supply of this material to industries requiring large quantities. Experiments were carried out in a type

of kiln comparable to those actually in use. The results obtained during the investigation go to show that the type of kiln used is capable of producing the highest quality charcoal and able to dispense with expert labour. A method has been evolved of reducing the percentage of volatiles. The charcoal so produced experimentally has been found by manufacturers to be of the quality they require. By a simple device, which makes the regulation of burning very nearly automatic and independent of wind conditions, positive control has been obtained over the rate and uniformity of carbonisation. These satisfactory experiments were followed up with investigations into methods of carbonising various timbers of different dimensions, as well as into the proper balance between maximum yield and low volatile content. There is at this time also an additional aspect of the use of charcoal. In the December 1939 issue of this journal we devoted space to an article on alternatives to petrol. The discussion therein was confined to the use of Diesel engines in motor vehicles and the possible use of coal gas; also mention was made of the encouragement being given by the British Government to gas-producer units for driving motor vehicles. It follows that the uses of charcoal fuel and wood for the same purpose should come under review. If producer gas is to be used for road traction to conserve as much as possible reserves of petrol for war purposes, there is the possibility of obtaining the gas not only from coal but from charcoal as well. Countries with petrol supply problems to face are particularly interested in such alternatives. Put on a proper basis the use of alternatives in such countries may even extend to peace conditions. Hence, research is being extended to include investigations into the possible use of producer-gas from wood and charcoal. If means are found for easy utilisation of this fuel, the field of exploitation of these materials will be increased immensely, considering the quantities of first quality charcoal already used by a number of industries. It would help a good deal if the same industries now using large quantities of charcoal in their various processes find themselves in a position to equip their fleets of motor vehicles of all kinds with producer-gas installations. In view of the cost of petrol in some countries such a course, if made possible and simple, could well reduce costs of operation, often a vital item in a competitive world. It should be noted that

the use of alternative fuel to petrol is on the increase. With the encouragement given by certain governments to the use of producer-gas for road transport, the interest in the simplest and easiest means of obtaining and utilising this fuel is bound to rise. For the moment, however, the Research Board has succeeded in the particular line of investigation concerned with the portable kiln, while not overlooking the added importance at this time of the possibility of producer-gas from wood and charcoal. We shall probably hear more of the latter in the reports to come.

Our own Forestry Department might well go ahead with research into such possibilities. The admirable work already being done in this country leaves ample room for extending investigations in this direction. There is an excellent opportunity here for co-ordination of effort, a subject of great concern to all and repeatedly urged in these columns. To a very considerable extent the work of one research body is known to others in the same field of investigation, but that is really not enough. Far more is required for real co-ordination. Politically, internationalism is at the moment at a discount; from the point of view of scientific investigation, however, collaboration with all other countries remains the object to be aimed at for the sake of the future of the world. The isolated piece of research we are dealing with in this article is only a drop in the ocean when compared with the total of research in various directions proceeding the world over. What we are seeking may not be found by any particular body of workers, but may come into being as a result of combined effort on the part of all, wherever they be bending their energies in one direction or other. Science knows no boundaries. Some of the work of research now proceeding would be unnecessary if the world were to learn how to co-operate, live in peace and share amicably all mother earth and human intelligence can give us. We often seek substitutes for materials available in sufficient quantities for all. Perhaps the time is coming when we shall know how best to share everything.—*Indian Engineering*, Vol. CVII, No. 3, dated March, 1940.

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FOREST DEVELOPMENT WORK IN THE UNITED PROVINCES

BY S. S. NEGI, P.F.S.,

Development Officer, Forests, U.P.

I.—INTRODUCTION

An overwhelming proportion of the population in India is dependent on agriculture and one of the most important aspects of forest management is to meet the requirements of the agricultural population. Amongst the peasants' greatest needs are firewood to replace cowdung, small timber for houses and wood for implements, as well as grazing for their cattle.

There can be little doubt that in the beginning of the 19th century there were forests stretching over the greater part of the U.P. sufficient to supply the demand of the agricultural population for timber, fuel and grazing, but with the advent of stabilised conditions in India, resulting in a great increase in population, a fierce onslaught was commenced on the forest areas and by the middle of the 19th century all traces of ancient forests disappeared except along the unhealthy submontane and *tarai* tracts. On this narrow strip and to a certain extent on the more accessible forests of the Himalayas is thrown the entire burden of supplying forest products for the teeming millions of the disforested plains.

Forests are a valuable asset for a nation. Experts estimate that about 20 to 25 per cent. of any country should be under forests to satisfy its need for timber, fuel, grass, etc. Finland has 73.5 per cent. under forests, Sweden 55 per cent. Austria 37.7 per cent. Germany 24 per cent., Switzerland 22.7 per cent., Norway 21.4 per cent., France and Italy 19 per cent. and Belgium 18 per cent. Great Britain has only about 5 per cent. under forests but millions of pounds are being spent annually on afforestation in spite of the fact that coal is easily available and the economic condition of the

people is such that they can afford to buy coal, timber and chemical manures. In the U.P., the area under forests excluding the hill forests of Kumaon, is only about 4 per cent. of the total area and that too is confined to a narrow strip along the submontane and *tarai*, and owing to the bad distribution and smallness of the forests, the people in the plains have to pay a very heavy price for timber, fuel, grass, bamboos and other forest products. In our province, there are about five million ploughs and at least the same number of houses and cowsheds and a million carts. The villagers, owing to the prohibitive cost of fuel and the lack of any practical alternative, are compelled to burn cowdung, the consumption of which is several million tons a year (see plate 19). If this enormous quantity of cowdung could be diverted from the village hearths to the fields in the form of manure, it would not only save the land from further deterioration but would greatly increase its productivity and thereby improve the economic condition of the peope. It would thus appear that there is an unlimited demand for timber, fuel and fodder and there is a great need for adding to the present supply by creating village fuel and fodder plantations in the plains on poor culturable and waste lands.

The Gangetic Plain, which is amongst the most densely populated and intensively cultivated tracts in the world, is notoriously deficient in timber and fuel supplies and adequate grazing grounds. Although the population is increasing every day, the land is progressively deteriorating owing to lack of proper manuring. At the last census (1921—31) the population of the province increased by 7 per cent. and it is estimated that it will show a further increase of about 12 to 13 per cent. at the next census. It is, therefore, obvious that, in order to cope with the ever-increasing population, the only solution is to put the existing cultivated land to the best possible use by proper manuring, improved seed supplies, better implements, irrigation, etc.

II.—CREATION OF THE FOREST DEVELOPMENT DIVISION

The Chief Conservator of Forests, U.P., as Chairman of the Provincial Fodder and Grazing Committee, has pointed out that the spearhead of the rural development activities must be agricultural improvement to improve the economic condition of the people

Cowdung Cakes heaped near villages in the plains for fuel.

Photo by S. S. Negi.

Taungya

One-year-old Taungya Plantation of Mulberry (up to 4 feet high) with wheat crop.

Locality—Mahboobnagar,
Bahraich Dist., U. P.

Photo by F. Robertson.

and laid great emphasis on the necessity of creating village plantations and better utilisation of the waste lands in the plains for timber, fuel and grazing. The U. P. Government realised the urgency of this activity for the improvement of agriculture and, independently of the Imperial Council of Agricultural Research, appointed a Forest Officer in December, 1937, to investigate the possibilities of creating fuel and fodder plantations in the plains and to devise ways and means for the better utilisation of waste lands. On his recommendation, a new Forest Development Division under the Forest Department was created in 1938.

The activities of the Division fall under the following categories:

(*i*) Creation of small village plantations for the production of timber, fuel and fodder, chiefly on culturable land by means of *taungya* or *bankheti*.

(*ii*) Utilisation of suitable waste land for planting up trees including canal banks, roadsides, village tracks, etc.

(*iii*) Utilisation of *usar* lands, unfit for tree growth, for grazing.

(*iv*) Checking of erosion by protection of natural vegetation and by small *bunds* where necessary.

(*v*) Increasing fodder production on village grazing grounds and fuel production on village scrub jungles.

The aim is to provide small fuel and fodder plantations in the villages sufficient to satisfy at least a part of the requirement of the rural population for timber and fuel and to improve the existing village grazing grounds by rotational grazing. The principle on which the work is being carried out is that whatever work and protection is done shall be done by the *zamindars* and villagers, who are the owners of the land, while the Forest Development Officer and his staff shall do the propaganda with the help and co-operation of the Rural Development Department, supply free tree seeds and plants of species which are not available locally and give technical advice and help to the people in raising forest plantations, protection of ravine lands and improvement of grazing on village grazing grounds and *usar* lands.

III.—PROPAGANDA

In the cold weather of 1938, propaganda was carried out in Meerut and Rohilkhand Civil Divisions, mainly amongst the *zamindars*, and meetings were addressed explaining the advantages of utilising their waste lands for timber and fuel production and better grazing. As a result, several *zamindars* offered their poor culturable and waste lands for forest plantations and a start was made at break of rains in 1938. It was, however, felt that although this aspect of forest development was extremely important, the villagers were not likely to be benefited by it. In the U. P., all the waste lands belong to the zamindars and as such the produce from these plantations would not be available to the villagers. It was, therefore, decided that the cultivators should also be included in the scheme and should be persuaded to set aside a part of their holding for this purpose to satisfy their need for timber, fuel and fodder. In the cold weather of 1939, intensive propaganda was carried out amongst the villagers also and meetings were addressed in more than 40 villages in the Meerut, Rohilkhand, Lucknow and Allahabad Divisions. There has been a great response from the villagers but the delay in the passing of the New Tenancy Act gave a setback to the scheme. Under the old Tenancy Act, the tenants were not permitted to plant trees on their holdings without the consent of the *zamindars* and if they did so, they were liable to be ejected. As a result of the passing of the New Tenancy Act, the cultivators, who have now been given the right to plant trees on one-tenth of their holding, are showing very keen interest in the scheme which will be clear from the fact that out of about 2,250 acres offered so far for plantation this year, about 1,500 acres belong to them. The main difficulties that have to be overcome by continuous propaganda to induce the cultivators to put a part of their cultivated land under forest plantations are:

(i) *The tenants do not possess any waste land and are, therefore, unwilling to put a part of their productive holding under forest plantations from which they are not likely to derive any benefit for several years to come.*

To overcome this objection, it is explained to them that fuel plantations play an important role in well organised agricultural

venture and are a great necessity for the improvement of agriculture, more so in the intensively cultivated localities. A small area set aside for the production of fuel is more than compensated for in increased yield from the remaining well-manured fields. It is estimated that every maund of fuel diverts several times the same weight of cow-manure from the village hearths to fields. If this farmyard manure was saved by raising fuel plantations, there can be no doubt that they will get more yield than they are getting now with less labour and less seed. The other advantages incidental to forest plantations, like supply of timber for agricultural implements, carts, huts and cowsheds and fodder for their cattle are also explained to them.

(*ii*) *The tenants will lose income from the fields put under forest plantations till the trees are big enough to yield fuel and small timber.*

The *taungya* or *bankheti* method has been considered to be most suitable to mitigate this difficulty and has been adopted in village plantations (see plates 20 and 21). In this, seeds of tree species valuable for timber, fuel and fodder are sown along with the field crops in lines one foot wide at 15 to 20-feet intervals. Soil is worked to a depth of nine to 12 inches. Field crops like *chari*, sugarcane and *urad* are to be avoided at least in the early stages of the development of seedlings as they are likely to choke the young seedlings. The plants, if properly tended and protected, will attain a height of 15 to 20 feet in four to seven years depending upon the quality of soil and subsequent protection and prevent further cultivation. When cultivation ceases, grass will come up naturally on these intervening strips and, if necessary, good quality fodder grasses will be introduced artificially. The cultivators by this method will begin to get some fuel out of the thinnings and fodder for their cattle from the time cultivation stops.

(*iii*) *Mango Trees.*—There is a great prejudice amongst the cultivators in favour of mango trees. Apparently there can be no objection to their planting mango trees but as fruit trees are not cut till they die, the cultivators will not get fuel and timber and if they are allowed to plant mango trees, the whole object of the scheme will be defeated. It is explained to them that they should,

instead of mango trees; plant trees such as *babul, sissoo, khair, neem, jaman,* mulberry and bamboo which can be grown easily and quickly and are necessary to satisfy their daily requirements for fuel and timber. They could, however, grow a few mango trees in one line for fruits for their family. Considerable difficulty was experienced in persuading them to give up this idea, which has almost become a tradition in the villages and it was with a great deal of propaganda and persuasion that most of them have come round and agreed to plant trees valuable for timber and fuel.

(*iv*) *Soil Preparation.*—In the forest divisions, soil preparation is usually done from April to June but the *zamindars* and *cultivators* refused to do the work in the hot weather. They promised to do it at the break of rains but when the rains came they got busy with their cultivation with the result that sowing was considerably delayed and the condition of the plantations is not as good as it should have been if sowings had been done in time. In view of the difficulties experienced in the last two years, it has been decided that every effort should be made to get the soil preparation done in the cold weather and, as far as possible, plots of only those *zamindars* and cultivators should be taken who are willing to do the work soon after the cold weather rains and, in any case, not later than the end of March. During this period the cultivators are comparatively free and labour is easily available and if the *zamindars* and cultivators are keen, the work can easily be finished before the harvesting of *rabi* crops begins.

The method adopted this year for propaganda and plantation work may be briefly summarised as follows:

Propaganda is done by the Development Officer and his staff from November to January. For this purpose, meetings are arranged with the help and co-operation of the Rural Development staff and lectures, illustrated with posters and lantern slides, delivered explaining the advantages of the scheme. In order to concentrate the work and take advantage of the rural development agency in the villages, meetings are arranged, as far as possible, in the rural development centres. The foresters and forest guards then go to the villages in which propaganda has been done and take the names of the *zamindars* and cultivators who wish to have planta-

After 16 Years

Sissu and Khair crop, 13½ years old. Teak of same age in background. The Sissu crop is 2 feet girth and 35 feet high. (Bhinga Taungya Plantation, Bahraich Division)

Photo by E. A. Smythies.

1½-year-old village plantation of Khair by Taungya (up to 15 feet high).
Locality—Nangawan,
Pilibhit District,
Raja Sahib of Pilibhit's land.
Photo by S. S. Negi.

tions on their land. The plots offered for plantation are then inspected and a list prepared for each district giving the owner's name, name of the village, area, quality of soil and the species best suited to the locality. Every effort is made to get such plots extended by inducing the tenants of the adjoining plots to join also. After finishing the preliminary work, the foresters and forest guards go round to the same villages soon after the cold weather rains to persuade the owners to start the work and render necessary help in carrying out soil preparation. At the break of rains, the staff will go again to these villages with the necessary seed and get the sowings done in their presence. They will go on visiting these villages throughout the rains to get the weedings done in time and see that the plantations are properly looked after and protected. In the suceeding cold weather, they will again get busy with the propaganda and supervision of the plantations. They will also help owners in carrying out thinnings where necessary.

IV.—WORK DONE DURING 1938 AND 1939

In 1938, work was done on land belonging to the *zamindars* in the Districts of Muzaffarnagar, Meerut, Bulandshahr, Bijnor, Bareilly, Pilibhit and Hardoi. These plantations served as demonstration plots and proved very useful in popularising the scheme amongst *zamindars* and cultivators equally. In 1939, the work was extended to Moradabad, Lucknow and Partabgarh Districts and propaganda was carried out in more than 40 villages. Enquiries from several other districts could not be followed up owing to the limited trained staff and funds.

The work done during the last two years may be briefly summarised as follows:

(*i*) *Village Plantations.*—In 1938 about 160 acres were sown up in seven districts at the break of rains. The plantations started very well (see plate 22) and were in good condition till the end of August but on account of the failure of monsoon and exceptionally dry cold weather, some of them subsequently failed.

In 1939, about 720 acres, including 1,938 failures in 10 districts and spread over about 140 villages and 320 plots, were sown up at

break of rains, out of which about 200 acres belong to the cultivators. Actually the cultivators offered about 600 acres for plantation but about 400 acres had to be given up at the last moment owing to the delay in the passing of the new Tenancy Act. The *zamindars* took advantage of this delay and refused to allow the cultivators to plant up trees on their land. Out of 720 acres planted up in 1938 and 1939, about 300 acres is fallow land belonging to the *zamindars* which was bare of grass on account of excessive grazing and did not yield any income to the owners. Only one season's closure has yielded grass sufficient to cover about half the cost of the formation of plantations. The work was again handicapped by the unfavourable monsoon conditions but the results are generally promising, and it is hoped that with favourable winter rains about 75 per cent. of the plantations will be successful. The failures will be done again at the break of rains.

(*ii*) *Usar Areas.*—There are about 3,000 square miles of *usar* in the United Provinces. The main use of these areas is and always will be grazing and fodder for about 40 millions of domestic cattle. It is a well-known fact that due to overgrazing, they are producing only a small fraction of the fodder that they can produce if properly controlled. It is estimated that if two-thirds of this area is closed to grazing for four to five months during the rains each year, the production of fodder will increase by about 16 to 18 million maunds of grass in the province.

Two types of *usar* lands are broadly recognised:

(*a*) *Semi-Usar.*—In semi-*usar*, the *kankar pan* is not continuous and patches of good soil occur here and there which is indicated by better growth of grass and often by thorny bushes. In these patches of good soil species like *sissoo, babul, dhak, neem* and *khair* can be easily grown.

A semi-*usar* area belonging to Khan Bahadur Sheikh Wahiduddin, C.I.E., near Meerut, has been taken up for afforestation and is being planted up gradually. Another area of about 1,200 acres in Partabgarh District belonging to the Kalakankar Estate has been taken up and will be planted up gradually from next year.

Commencement of erosion as a result of heavy grazing.

Locality—Near Barahwa F. R. H.,
Gonda Forest Division, U. P.
Photo by E. A. Smythies.

Babul Plantation on Rawna land.

Locality—Etawah District, U. P.

Photo by E. A. Smythies.

As these areas will remain closed to grazing for six to eight years, they will automatically be improved for grazing also.

(*b*) *Real Usar.*—Real *usar* has an impenetrable *kankar pan* or impermeable alkaline subsoil which interrupts the progress of the roots. Tree crops are generally deep-rooted and have, therefore, little chance of establishing themselves in such areas. They can only be improved for grazing by introducing periodic closure.

In order to demonstrate to the rural population the benefit that will result by suitable protection from grazing, it is proposed to start small demonstration plots in every district. In 1939 two plots of about 10 acres each in Lucknow (Gauri Village) and Bareilly (Fatehgunj-West) Districts have been fenced with cattle-proof fence. The results obtained by one season's closure are very promising and the growth of grass in these plots is very much better than in the adjoining overgrazed areas.

Although it has been definitely established by experiments carried out by the Forest Department that by annual protection during the rains the production of fodder will increase considerably, the crux of the problem is how to apply it to the village conditions. In the U.P., all the *usar* and waste lands belong to the *zamindars*, who are not likely to spend any money to improve them mainly for two reasons, *viz.*, they do not require extensive grazing grounds for their own cattle, and they are not likely to get any income from grazing. On the contrary, any attempt to impose grazing fees might create agitation in the villages. The only solution which appears possible, therefore, is that the Government should acquire a few blocks in the vicinity of those villages where Village *Panchayats* and Better Living Societies are properly functioning and hand over the blocks to these societies for the improvement of grazing under the supervision and direction of the Development Officer. A recommendation to this effect has been made to the *Usar* Committee and a start will be made in a few districts as soon as funds are available for this purpose from the Committee.

(*iii*) *Control of Ravines and Erosion.*—Simple protection from cattle in the ravines and over a strip at the head of the ravines is sufficient to bring back the natural vegetation and check further erosion (see plates 23 and 24).

Three ravine areas in Budaun District have been closed to grazing. The *zamindars* and cultivators are at present doubtful if mere closure to grazing will check erosion and are unwilling to appoint *chaukidars* at their expense. In order to convince them it has, therefore, been decided to wire-fence these areas with cattle-proof fence at Government expense for a period of about three years. The cost of putting up the fences has been met by the *zamindars* and cultivators. The cultivators are now being persuaded to make a mud-wall about one foot high and one foot wide along their fields on both sides of the ravines and small *bunds* where necessary and it is hoped that by the beginning of next rains the mud-wall and *bunds* will be ready.

Another area of about 30 acres has been taken up in the Moradabad District. In this area no wire-fence has been put up but a forest guard has been appointed to look after it. He also supervises the plantation work in the adjoining villages.

(*iv*) *Nurseries and Seed Stores.*—Three central nurseries have been started at Partabgarh, Bareilly and Meerut for the distribution of plants to the rural population. About 8,700 and 51,000 plants of forest, fruit and ornamental species were distributed in 1938 and 1939 respectively to the *zamindars* and cultivators free of cost.

Two seed stores have been started at Bareilly and Meerut. About 33 maunds and 275 maunds of seeds of forest species were used for village plantations in 1938 and 1939 respectively.

V.—ORGANISATION

There being no certainty as to whether the Forest Development work will become popular with the people, the organisation had to be developed gradually and the staff increased as the work expanded. In 1938, the Development Officer carried out propaganda single-handed and when sufficient area for plantation was assured, four foresters and eight forest guards were taken on deputation from the Forest Department in June, 1938. They were replaced in October, 1938, by four foresters and eight forest guards especially recruited for the Division after completing about three months' training in the forest divisions. It was subsequently found that such a short training was not sufficient for foresters and four foresters were, therefore, deputed to the U.P. Foresters' Training Class in

November, 1938. The work in 1939 having increased and the foresters sent for training not being available at the time of soil preparation and sowing, four foresters and eight forest guards were again taken on deputation from the Forest Department in April, 1939, for about three months. They were relieved in July by the four foresters who had returned by then from the training class and eight forest guards who were put under training in the division under the forest staff. This was, however, also not found satisfactory as these short deputations did not find favour with the divisional forest officers and the staff and the foresters sent for the foresters' training class were not available at the time when they were required for plantation work. It was, therefore, decided to give the foresters to be recruited in future training for seven months (from June to December) in the Forest Divisions and three months (from January to March) in the Development Division. In this way they will get a thorough training in soil preparation, sowing, weeding, thinnings, etc., in the forest divisions and will acquire a fair knowledge of the type of work they will require to do in the Development Division. They will also get familiar with the rural condition and rural life. The forest guards will be trained in the Development Division from June to March and not sent to the Forest Divisions. This procedure for the training of the staff will, it is believed, prove more satisfactory and will be adopted in future.

The work in 1939 having increased considerably over an extensive area spread over 10 districts from Muzaffarnagar to Partabgarh, it was felt that the Development Officer could not possibly control the work efficiently, and one Forest Ranger and one Deputy Ranger were taken on deputation from the Forest Department before the break of rains in 1939 to help him in controlling the work. They will remain in the division till the forest development staff is sufficiently experienced to take their place. Experience gained during the last two years indicates that the work is likely to expand beyond all expectations and a stage has reached when the Government should be given an idea of the staff and funds that will be required for the future development of the scheme. The Chief Conservator of Forests, U.P., accordingly submitted a note in July, 1939, to the Government for the consideration of the Finance Committee dealing with the expansion of the activities of the Forest Department in the plains districts.

The broad outline on which the programme is to be developed is as under:

(*i*) *Unit.*—The unit of management will be a division covering eleven civil districts or two civil divisions in charge of a gazetted and trained forest officer (*i.e.*, ultimately four units for the province).

(*ii*) *Staff.*—In each unit, there will be two rangers (one ranger per civil division), 11 foresters (one forester per civil district) and 50 forest guards (one forest guard per tehsil). The staff will be increased gradually in each unit.

(*iii*) *Cost.*—The cost per unit will be as under:

Year	Cost	Remarks
	Rs.	
1st	10,000	The cost excludes the pay, T. A. and carriage of the Forest Development Officer and his personal Staff.
2nd	17,500	
3rd	25,000	
4th	31,000	
5th	37,000	

Each unit will probably take about five years to organise and develop.

The Government will decide how fast the work should develop and can create new units as the development and popularity of the plan makes it advisable. Assuming the scheme proves popular, the following tentative proposals have been made for the next five years:

Financial year	Year	1st unit	Year	2nd unit	Year	3rd unit	Total cost of year
		Rs.		Rs.		Rs.	Rs.
1940—41	3rd ..	25,000	..	..	..	..	25,000
1941—42	4th ..	31,000	1st ..	10,000	..	..	41,000
1942—43	5th ..	37,000	2nd ..	17,500	..	..	54,500
1943—44	6th ..	37,000	3rd ..	25,000	..	..	62,000
1944—45	7th ..	37,000	4th ..	31,000	1st	1,0000	78,000

N.B.—Work in the 1st unit has been done for two years and 1940-41 will be the third year of the unit.

The staff in 1938, when the division was created, consisted of the Development Officer and one camp clerk. During the last two years, the staff was gradually increased as the work developed and now consists of one Forest Development Officer, one forest ranger, one deputy ranger, eight foresters, 18 forest guards, one senior assistant clerk and one camp clerk. The arrangement at present is that the Forest Department will supply an experienced gazetted forest officer for each unit and meet the expenditure on his pay, T.A., carriage and his camp staff while the Rural Development Department and the *Usar* Committee will pay for the subordinate staff, seed, nurseries, improvement and protection of grazing grounds and waste lands.

GRAZING CONTROL IN RESERVED FORESTS

By K. P. Sagreiya, I.F.S.

"The only hope of checking the growing evil, which is accelerated by *laissez faire*, is considered to be in some form of Government intervention. The utmost importance is attached to the institution of rotational grazing, combined with the multiplication of water supplies, the control of grass burning and a control of the type and number of stock which may use each of the units of grazing which would be demarcated and developed."
—Jacks & Whyte in *The Rape of the Earth.*

As one who has given a certain amount of thought to this vexed question of regulating grazing in the reserved forests, I am very disappointed to read of the fate of Mr. Garland's draft grazing rules for Bombay (published in the *Indian Forester* for July, 1939, pp. 445 *et seq.*). It is to be regretted that the rules should have been dropped by Government simply because they were not "in accord with public sentiment" without apparently any regard to their intrinsic merit or a critical examination of the popular objections to see how far these are reasonable or based on misconceptions, sentiments or short-sightedness.

As a member of the Industrial Survey Committee* appointed some time ago in the Central Provinces I had an opportunity of discussing this question of satisfying the demand for grazing in the reserved forests in the most amicable manner with persons who carry weight with the masses. I am not letting out any official secret when

* Report of the C. P. & Berar Industrial Survey Committee, 1939.

I say that as a result of this experience I was convinced that the opinions of these spokesmen of the public are mostly based on incomplete study, sentiment or political bias. Lest these remarks appear too sweeping I quote a few of the opinions:

MEMORIAL BY THE COW PRESERVATION LEAGUE, CALCUTTA, TO H. E. THE GOVERNOR, C. P. AND BERAR

(*i*) "The number of cattle is grossly inadequate and is decreasing year after year."

(*ii*) "The shortage (the extent is meant, not the quality) of grazing grounds is responsible for the unsatisfactory condition of the cattle."

(*iii*) "Foremost amongst the causes of steady degeneration of cattle is their numerous and unrestricted slaughter."

(*iv*) "The system of stall-feeding is thoroughly unsuitable in our climate and cattle deteriorate thereby."

MONOGRAPH ON DAIRY INDUSTRY, PUBLISHED AS A PART OF THE INDUSTRIAL SURVEY COMMITTEE'S REPORT

(*v*) "The wretched condition of the cattle is due to:

(*a*) The influx into large towns of thousands of milch cattle which eventually fall into the hands of the butcher;

(*b*) The state granting grazing licenses to the largest numbers of animals in order to realise more money, with the result that the livestock is underfed; and

(*c*) There being no provision for cutting grass at the right season or for reserving any areas for bad days."

THE MAIN REPORT OF THE ABOVE COMMITTEE

(*vi*) "One great difficulty the dairy farmer finds is of grazing lands. Although there is a large number of cattle there is very little grazing land per head of cattle. . . . Government should find ways and means of allotting much greater area for grazing lands at reasonable rates and we suggest that immediate steps be taken to prevent the diversion of commercial lands for cultivation.

REJOINDER TO THE NOTE* SUBJECT TO WHICH I SIGNED THE REPORT

(*vii*) "Where is the generosity in (the Forest Department) giving rocks for grazing? Fodder cannot be imported from the Himalayas. A hurdle of higher rates will merely help the rich at the expense of the poor."

Conditions in Bombay could not be very different from those in the Central Provinces and it is for consideration how far such opinions (and they are little else) should be allowed to carry weight against the findings of technical experts when deciding broad questions of policy where the ultimate aim is to do the greatest good to the largest number, including posterity.

I have, therefore, taken the liberty of offering this second opinion on this problem of regulating grazing in the reserved forests in the hope that it will be given the consideration it deserves when the Bombay rules are redrafted.

As I have said before, I am familiar only with the conditions in the Central Provinces. [See writer's note on "The Livestock Problem of the Province *vis-a-vis* Grazing," C. P. Forest Bulletin No. 2, 1940.] My acquaintance with conditions in other provinces of India is confined to what I have read. It is quite likely, therefore, that some of my comments on Mr. Garland's rules may be of purely academic interest to Bombay.

Before dealing with the draft Bombay grazing rules, I will enunciate a few general principles, based on well-known facts, which should guide us when framing the grazing policy.

It is an admitted fact that production of timber and provision of grazing are conflicting demands on land, which can overlap only to a certain extent. When the limit of safety is exceeded, the

* Herein I had stated: "Ninety per cent. of the reserved forest is open to grazing and the remainder open for the removal of grass at any time. It is true, however, that the grazing is not of a high quality and in places the areas have been "licked bare" and now serve as mere exercising grounds for the cattle." I, therefore, urge that grazing should be commercialised to discourage the keeping of useless stock and to obtain funds for improving the grazing grounds. Indeed at a later stage, as a half-way house, I even advocated free grazing for the *essential* cattle, provided that the rates for the *surplus* uneconomical animals could be gradually raised and eventually made prohibitive.

physiological balance of the plant community is so upset that both the tree growth and the pasture rapidly deteriorate. The extensive "waste lands" in the country are typical examples of such retrogressive succession. It is thus of the utmost importance that the optimum balance between tree cover and the adverse agency of grazing must be maintained, in order to perpetuate the forest as well as the pasture, both of which supply the basic needs of the population. Hence the need for restricting grazing both in intensity and in duration. Here it will bear repetition that even this fundamental fact is completely lost sight of by the leaders of public opinion when making their recommendations for regulating grazing in the reserved forests.

Similarly, it is a well-known fact that the condition of the livestock, which are the mainstay of the agriculturists, is miserable and and their utility value low—often a negative quantity. It is a common observation that animals which are almost entirely dependent on forest grazing are far inferior to the animals in intensively cultivated or industrialised tracts, because in the latter the owners are perforce obliged to feed them at the stall, when they can afford to rear only efficient cattle.

On the whole, there is a very considerable number (variously estimated at from 20 to 60 per cent.) of uneconomic animals who are not only a liability to their owners but also a serious drain on the already meagre fodder supplies.* There is little doubt that, with better management, a very much smaller number could furnish all the labour and milk products needed for the country. The available fodder per animal is also low because of (*i*) the almost total absence of organised pastures or cultivation of green fodder, and (*ii*) the poor condition of the grazing grounds.

It has not been realised that in our climate we cannot have permanent pastures—except where the rainfall is well distributed or irrigation facilities exist. Instead, we have an annual crop of grass from July to December. For the rest of the year animals have to subsist in a state of semi-starvation on whatever they can pick up from waste lands and indeed on their own reserves.

* "In no other country in the world, save India, are cattle a burden on the land or its people."—*Mahatma Gandhi.*

Lastly, it is necessary to emphasise that the main defects in our livestock management are the low fees charged for grazing—either as a matter of policy or as sentiment—and the apathetic attitude of the people to restrictions on grazing.

It will thus be seen that the existing conditions are, as it were, a race up a vicious spiral between uneconomic livestock and denuded pasture. The faster the livestock chases the pasture, the farther it recedes owing to diminished production. What is required is to make an attempt to bring them down the vicious spiral by providing more fodder and at the same time reducing the number of animals. Once they are on the level ground, that is, when there is an optimum balance between the livestock and the fodder yield (which is possible only when the present low rates are replaced by the market rate), we could proceed towards the set goal of increasing the utility-value of the livestock by improving the yield and quality of fodder as also the breed of animals.

I have little doubt that, had Mr. Garland's draft grazing rules been examined in the light of these facts, rather than tested on the touchstone of "public sentiment" they would not have been scouted as impracticable. The following remarks and facts are offered in support of this:

Rule I.—Part one of this rule merely reiterates the basic facts that uninterrupted heavy grazing is wasteful and ultimately leads to a retrograde succession. One has only to visualise the bare trap hills of Deccan to realise the truth of this statement.

Part two is a natural corollary to part one. It may be argued that the Forest Department is mainly charged with increasing the yield from the grazing grounds and, therefore, it should advocate restrictions only to the extent necessary to secure this. Its duty ends there. It should be no concern of the Department to see how the available fodder is utilised—whether for feeding a small number of productive cattle, or a large number of uneconomic animals. This will be too parochial a view, ignoring the fundamental problem, *viz.*, improvement of the utility-value of the livestock, and, the ultimate aim,—the welfare of the people at large. It is very desirable that the question of utilising the grazing grounds in the best manner must also receive the attention of forest officers.

Rule II.—Mr. Garland has here actually subordinated his better judgment to popular clamour. He has not fully realised the inevitable consequences of the dangerous prescription that "normally all lands in charge of the Forest Department shall be open to free and unrestricted grazing." We in the Central Provinces have learnt by bitter experience of the dire consequences of this policy of drift.

The provision of buffer-belts along the fringes of forests abutting on villages, where continuous grazing at concessional rates is to be allowed, is at best only a palliative measure. Once the pasture over this "safety valve" has deteriorated, as it must in course of time, there will be further agitation to provide fresh areas by excision from the forest where grazing is admitted under control. The inevitable result will be that pastures will recede farther and farther and the problem will become more and more acute.

In the Central Provinces we had only recently to classify our forests *de novo* to provide such safety valves for accommodating the surplus livestock, and we know only too well that this has not in any way eased the situation.

Rule III.—This lays down the broad principles upon which restrictions should be enforced. These are:

(*i*) Discrimination between essential or rather productive animals and the surplus, *i.e.*, uneconomic livestock, and preferential treatment to the former;

(*ii*) Adequate grazing grounds for the favoured animals;

(*iii*) Limiting the incidence to the carrying capacity of the pasture to prevent its further deterioration;

(*iv*) Rationing of permits to "listed" villages or even individual cattle owners, where animals seeking admission exceed the carrying capacity;

(*v*) Deterrent penalties for breach of rules;

(*vi*) Setting aside of "public ranches" for the surplus, unprovided for, livestock.

A critical examination will show that every one of these restrictions is well thought out and is proposed in the best interest of the cattle owners themselves and not with any desire to obtain more revenue, much less to harass the people.

Thus, the differentiation between the "essential" and the "surplus" livestock is a prime necessity in the present state of affairs. It might be interesting to mention here that the C. P. grazing rules which are in force since 1915 are based on this principle and have worked admirably well. In fact this is one of the few redeeming features in our otherwise gloomy grazing policy. The C. P. method is as follows:

After a forest working plan has been prepared a special revenue officer is appointed to examine the prescribed grazing closures and incidences and to make provision for grazing in the most amicable manner. This is known as a Grazing Settlement. The revenue officer and the working plan officer conduct a village-to-village enquiry in as many villages as possible which have depended in the past on the reserved forests for grazing, or which desire their claim to be considered. Among other things, during this enquiry, the following facts are recorded, and a "list" prepared of villages which *prima facie* appear entitled to the privilege of forest grazing:

(*a*) Distance from the reserved forest.

(*b*) Cattle population, acreage and nature of cultivation.

(*c*) Private grazing grounds available.

At the same time the reserved forest which has already been subdivided,* for purposes of grazing control into: (A) TREE FOREST;

*A.—TREE FOREST.—The remoter and better quality forests on which there is practically no demand for grazing and where production of timber is the primary object of management:

(*i*) *Moist type*, where the rainfall exceeds 45 inches. Here, as a rule, rank grass obtains, which hinders the regeneration of tree species and, therefore, grazing is actually encouraged by fixing extremely low rates and providing facilities for penning cattle. Care is, however, taken to see that the incidence will not exceed one animal for every four acres, and to close the area entirely when this is warranted to induce and protect regeneration.

(*ii*) *Dry type, i.e.*, where the rainfall is 45 inches or less. These are more accessible and there is a fair amount of grazing demand on them. In the interest of tree growth, however, the limiting incidence is fixed at three acres for mixed and two acres for teak forests, per animal, and periodic rotational closures (five-year closed, 10—15 years grazed) are provided to protect regeneration and later to allow pastures time to recover.

B.—SCRUB FOREST.—The isolated blocks of forests interspersed with cultivation. The tree growth has suffered from past heavy grazing and incendiary fires, the demand for grazing is very heavy and cattle depending on them have no alternate grazing facilities. Here, therefore, preservation and improvement of the pastures has been deemed the primary object of management and grazing restrictions are imposed solely with the object of increasing the fodder yield from these areas:

(Continued p. 416)

(*i*) moist type, (*ii*) dry type and (B) SCRUB FOREST; (*i*) Pasture Forests and (*ii*) Open Pastures, is further partitioned into a convenient number of grazing units whose size varies roughly inversely as the grazing demand on it. This done, the carrying capacity of each unit is worked out according to the prescribed limiting incidence and the average area open to grazing. When this exceeds the number of cattle seeking admission, all are admitted. When, however, it is less than the number seeking admission, as is sometimes the case, a selection is made. For this purpose three classes of cattle are distinguished:

(*i*) *Privileged.*—That is absolutely indispensable for *bona fide* agricultural purposes: a liberal limit of four per working plough is allowed;

(*ii*) *Ordinary.*—That is needed for quasi-agricultural pursuits such as supply of milk, manure and draught animals: four animals over and above the privileged cattle are thus allowed; and

(*iii*) *Commercial.*—That is the remaining surplus livestock.

The *privileged* and thereafter the *ordinary* cattle of all "listed" villages are given priority and *commercial* cattle (first of the listed villages and then of others) are admitted only if there is room.

The average rates charged for the three classes of cattle work out at privileged Re. 0-1-8, ordinary Re. 0-5-0 and commercial Re. 0-12-0 per animal, per year, and are thus far below the rates charged by owners of private grazing grounds which are much inferior in quality.

Besides this, in the grazing settlement accompanying the working plan for Nagpur-Wardha, prepared by the writer in 1934, another wholesome convention was started to prevent misuse of the privilege, namely, of allowing concessional rates only to cattle

(*i*) *Pasture Forests* or, to give them a more expressive name, *Wooded Pastures*, are forests which contain a certain amount of tree growth which can be exploited under a regular system without interfering with the grazing demand. Besides restricting the incidence so as not to exceed one animal per acre, they are also subjected to short rotational year-long closures to grazing primarily to allow pastures to recover.

(*ii*) *Open Pastures* are the areas containing very open thorny scrub not fit to be exploited under a regular system, but plenty of grass. The demand for grazing is so acute that neither can the incidence be limited without causing genuine hardship nor can any closures be enforced until people have been convinced of their necessity.

tilling land within five miles from the grazing unit, *i.e.,* only to daily grazing, bonâ fide, agricultural cattle.

Coming to the restrictions (*ii*) and (*iii*) in Mr. Garland's rules, it is but natural that provision should be made to give adequate grazing to the favoured cattle by excluding others, and by restricting the incidence to what the pasture can bear without deteriorating. Rationing of permits (*iv*) and setting aside public ranches for the surplus animals (*vi*) are proposals almost similar to what we are doing in the C. P. Thus only (*v*), that is a provision for inflicting deterrent punishment for breach of laws, is a suggestion which might possibly be objected to. It is no doubt done with the best of intentions, but perhaps a better procedure would be to make the cattle owners themselves responsible for preventing trespass in the areas leased out to them.

Rules IV and V.—So far, in the Central Provinces, goats and sheep are excluded from most of the forests as they are believed to be voracious feeders, browsing even tree species. Of late, however, it has been urged that sheep are harmless and that they be permitted over certain areas ordinarily closed to browsers.

For purposes of working out the grazing incidence, the norm is calculated as under:

"White" cattle (cow, bull or bullock) ...	1.
Buffalo	2.
Goat or Sheep	1/4.

Lastly, there is the question of the authority which should be made responsible for judging what restrictions on grazing should be imposed and how they are affecting the people. As I have aready mentioned, in the Central Provinces the *grazing settlement* is prepared, in the first instance, by the special Revenue Officer and the Working Plan Officer in collaboration. But finality is reached only after a thorough discussion at a conference which is fully representative of non-official opinion as well. The actual instructions are:

"Usually non-officials are informally consulted by the special revenue officer during the course of this enquiry, but this does not give them sufficient opportunity to make formal suggestions regarding or objection to the working plan and to the recommendations in regard to it, finally made to the local government. It is, therefore, ordered that representatives of local opinion, *e.g.*, members of the legislative council, members of the district council and local boards of the district and representatives

of local associations and landed interests should be invited to the conference held after the tour of the special revenue officer and given a definite opportunity of criticising the prescriptions of the working plan. It shall be the duty of the special revenue officer to explain to the conference how far the interests of the people are affected by the plan and, in drawing up his final report consistently with the principles herein enunciated, to consider the views expressed by the representatives. Proceedings should be drawn up showing clearly the opinions put forward and the general conclusions come to and accepted at the conference."

I conclude this somewhat lengthy brief by repeating that the Bombay draft grazing rules are not only based on a scientific diagnosis of the malady, but they prescribe the most wholesome and feasible treatment which alone will enable the country to get out of the ever-widening maze of—

Poor Pasture
Low cattle efficiency
Tendency to increase the herd
(whose maintenance costs little)
to make up for decreased efficiency.
Heavier incidence resulting in further deterioration
of pasture, less fodder per animal and increased difficulty in
imposing restrictions, etc., *ad infinitum,* which is
eating into its very vitals.

A NOTE ON DEYEUXIA MUNROI (BOISS.) BOR.

By N. L. Bor

A description is given of Aitchison's interesting plant (No. 1251) from the Kurram Valley. The grass is here transferred from *Calamagrostis* to the genus *Deyeuxia*. *Deyeuxia munroi* (Boiss.) Bor comb. nov. Syn. *Calamagrostis munroi* Boiss.. Flor. Orientalis V. (1884) 526.

This species, for which the above new combination is being made, was collected by Dr. J. E. T. Aitchison in the Kurram Valley, Afghanistan, in 1879, between 9,000 and 11,000 feet. The results of the collection were published in the Journal of the Linnean Society, Vols. XVIII and XIX. In Vol. XVIII, page 107, this species is recorded under No. 1251, *Deyeuxia*, with a note by Munro; "*Deyeuxia* sp near *D. varia* Kunth. I have never seen any specimens previously from India; perhaps a new species." Boissier, however, loc. cit.,

quotes this number and published it as a species of *Calamagrostis* sect. *Deyeuxia* Beauv. Admittedly *Calamagrostis* and *Deyeuxia* are closely related, nevertheless they can be readily separated by the following characters. In *Calamagrostis* the glumes are narrow and acuminate, the lemma is short and thin, the awn is straight and the callus long-bearded. *Deyeuxia*, on the other hand, possesses glumes which are broader and less, or not, acuminate, a lemma which is firmer and often as long as or almost as long as the glumes, awns which are well-developed, twisted and geniculate, and a callus which is shorter-bearded or glabrous.

Aitchison's No. 1251 is extremely interesting in that in most of the spikelets examined by me the rhachilla is produced and seated upon it is an immature lemma with a well-developed basal awn. The awn of the fertile lemma is basal, geniculate and twisted below the knee. The lemma is firm and about three quarters the length of the upper glume; it is scabrid on the back.

As Boissier's description of this interesting plant only runs to a few lines, it is considered that a full-length description will serve a useful purpose.

Deyeuxia munroi (Boiss.) Bor.

A perennial grass erect from a slightly geniculate base; branching intravaginal; base of plant covered with the remains of old sheaths. Culm up to 100 cm. tall, three-noded, erect, slender, glabrous, polished and smooth except just below the panicle where it is definitely rough for two cm. or more; nodes glabrous. Leaf-blades linear from a slightly rounded base, tapering to a filiform tip, up to 25 cm. long by 2.5 mm. wide, minutely scaberulous on the margins; surfaces rough; leaf-blades from the uppermost sheath subulate, firm, scaberulous; sheaths closely fitting, smooth and glabrous, striate, usually much shorter than the internodes; ligules up to three mm. long, membranous, lacerate.

Inflorescence a strict panicle ten cm. long by one cm. wide; branches short, erect, shortly branched, very scaberulous, arising in fascicles from the nodes; central rhachis terete or obcurely angled, very scabrous; pedicels up to three mm. long, filiform, dilated at the tip, scaberulous. Spikelets eight mm. long, lanceolate in shape, very crowded, erect, slightly gaping. Lower glume 7.5—8.5 mm. long,

lanceolate-acute, the glume appears acuminate before it is flattened out, keeled, scabrid on the keel, scaberulous elsewhere on the back, one-nerved, membranous; upper glume 7.5—8.5 mm. long, similar in shape and texture to the lower glume, three-nerved, the two lateral nerves being short. Rhachilla jointed above the glumes. Lemma five-six mm. long, membranous, five-nerved, oblong-lanceolate in shape, acute at the tip, shortly hairy on the callus, awned from just above the base on the back; awn about nine mm. long, strongly twisted and kneed, antrorsely scabrid; palea as long as the lemma, two-nerved, oblong-acute, hyaline, bifid at the apex. Stamens three, three mm. long; styles two, short; stigmas feathery. Rhachilla produced, up to three mm. long, penicillate with hairs two-three mm. long, sometimes short and surmounted by an empty lemma four mm. long which is awned just above the base; awn eight mm. long, twisted at the base.

This species is most closely related to *D. sylvatica* Kunth, but differs from it by its larger spikelets and scabrid glumes and lemma.

ANNUAL SPORTS AT THE FOREST RESEARCH INSTITUTE, APRIL 1940

BY C. R. RANGANATHAN

The combined athletic sports meeting of the Forest Research Institute and Colleges was held on the afternoon of Saturday, 6th April, 1940. This year's meeting was of special interest in several ways. It followed on the first Convocation of the Indian Forest College started two years ago for training personnel for the superior forest services in the provinces and states. The students of this College who had been prevented from taking part in last year's sports through absence from Dehra Dun on tour joined in the sports this year with creditable results. By a happy coincidence the Sports Day fell immediately after the session of the Advisory Board on Utilisation and consequently several senior members of the Indian Forest Service and other distinguished members of the Board were able to be present at the meeting. The sports were held, for the first time, on the new sports ground of the Indian Forest College and full advantage was taken of the well fitted pavilion on the

ground. The tracks were laid and the ground arrangements efficiently made by the Curator of the Institute.

The President and Officers of the Forest Research Institute and Colleges were "At Home" to the guests who had been invited to witness the sports, among whom were the heads of the local educational institutions, district officials and the local gentry. The Honourable Sir G. S. Bajpai, Member of the Governor-General's Executive Council, and Lady Bajpai were also present.

The arrangements for the "At Home" were in the hands of Mrs. N. L. Bor, who spared no pains to make the tea the great success it was. She was ably assisted in her work by the members of the New Forest Ladies' Club. The tea was served in the shade of two spacious *shamianas* pitched close to the pavilion.

The staff of the Forest Research Institute and the students of the Indian Forest College and of the Indian Forest Ranger College competed in all events. The programme for the sports followed closely that adopted last year, except that the tug-of-war event which had been dropped last year was restored and a new event in the shape of a fast cycle race was introduced. Unfortunately, owing to want of time, the Officers' Race and the Ladies' Race, which had been expected to produce much amusement, had to be dropped.

All the events were keenly contested by the two Colleges and the Institute and a fair share of the honours fell to each competing unit. Special mention must be made of the Championship Cup which was won in a very convincing manner by G. S. Dhillon of the Indian Forest Ranger College who scored six first places, thereby obtaining 30 points out of a possible total of 45 points.

Our thanks are due to Captain G. Hawks who acted as Chief Starter most admirably.

Lady Bajpai very kindly gave away the prizes and the function came to a close with three cheers for Lady Bajpai.

The results of the sports are shown below:

ATHLETICS

Long Jump

1. G. S. Dhillon (I.F.R.C.).
2. Indrapal (F.R.I.)

Throwing the Cricket Ball

1. G. S. Dhillon (I.F.R.C.).
2. Ashaq Hasan (F.R.I.).

Putting the Weight

1. G. S. Dhillon (I.F.R.C.).
2. Mohd. Habib Khan (I.F.C.).

High Jump

1. G. S. Dhillon (I.F.R.C.).
2. K. Kerr (F.R.I.).

100 *Yards Race*

1. G. S. Rana (F.R.I.).
2. S. M. Sibtain (I.F.C.).

Hurdles Race

1. K. L. Lahiri (I.F.C.).
2. K. Kerr (F.R.I.).

Sack Scrimmage

1. G. N. Singh (I.F.C.).
2. Bogle (I.F.C.).

Slow Cycle Race

1. S. P. Sahi (F.R.I.).
2. K. Kerr (F.R.I.).

220 *Yards Race*

1. G. S. Dhillon (I.F.R.C.).
2. G. S. Rana (F.R.I.).

Relay Race

Indian Forest College.

Fast Cycle Race

1. M. S. Zaman Khan (I.F.R.C.).
2. Shiva Dan Singh (I.F.R.C.).

Half-Mile Race

1. G. S. Dhillon (I.F.R.C.).
2. Indrapal (F.R.I.)

Tug-of-War

Indian Forest College.

Spar Fighting

1. S. S. Bahadur (I.F.R.C.).
2. M. P. Akhouri (I.F.R.C.).

Obstacle Race

1. Indrapal (F.R.I.).
2. T. J. Thapa (I.F.R.C.).

OUTDOOR GAMES

TENNIS, MEN'S OPEN SINGLES

(CUP PRESENTED BY MR. A. D. BLASCHECK.)

Winner

Satya Karma Kukreti.

Runner-up

Latif-Ullah.

TENNIS, MEN'S OPEN DOUBLES

(CUP PRESENTED BY MR. L. R. SABHARWAL.)

Winners

Satya Karma Kukreti.

Latif Ullah.

Runners-up

U. S. Madan.

M. Fakhruddin.

TENNIS, MEN'S HANDICAP SINGLES

(CUP PRESENTED BY MR. W. T. HALL.)

Winner

Satya Karma Kukreti.

Runner-up

U. S. Madan.

TENNIS, MEN'S HANDICAP DOUBLES

(CUP PRESENTED BY DR. N. L. BOR.)

Winners

Satya Karma Kukreti.

Latif Ullah.

Runners-up

Mazahar Uddin Ahmed

G. N. Singh.

TENNIS, MIXED OPEN DOUBLES

(CUP PRESENTED BY SIR GERALD TREVOR.)

Winners

Mrs. S. Ramaswami.

Mazahar Uddin Ahmed.

Runners-up

Mrs. C. R. Ranganathan.

U. S. Madan.

MIXED BADMINTON, DOUBLES

Winners

Mrs. C. R. Ranganathan.

K. Kerr.

Runners-up

Mrs. U. S. Madan.

M. Mahboob Ali.

R. K. BANERJI MEMORIAL CUP FOR BADMINTON

Winners

D. R. Sood.

K. Kerr.

Runners-up

G. N. Singh.

N. S. Kaikani.

THE FOREST FOOTBALL CHALLENGE CUP

(PRESENTED BY SIR ALEXANDER RODGER.)

Winners

F. R. I.

SEAMAN CRICKET CUP

(PRESENTED BY MR. L. N. SEAMAN.)

Winners

F. R. I.

(CRICKET BAT PRESENTED BY DR. N. L. BOR.)

Nur-ul-Hasan.

THE MASON-JASPAL HOCKEY CUP

Winners

Indian Forest Ranger College.

VOLLEY BALL CUP

Winners

Indian Forest Ranger College.

INDOOR GAMES

Auction Bridge

Mazahar Uddin Ahmed.

R. C. Soni.

Game of Twenty-Nine

K. L. Lahiri.

B. N. Prashad.

Ping-Pong

S. M. Sibtain.

Chess

P. C. Batra.

Carrom Singles

D. C. Roy.

Carrom Doubles

J. N. Banerji.

G. Misra.

TWO NOTABLE EXAMPLES OF NATURAL REGENERATION UNDER THE UNIFORM SYSTEM

By W. T. Hall, I.F.S.,

Conservator of Kumaon.

The following notes on two examples of natural regeneration from seed under the uniform system may be of interest. One is in almost pure forest of oak, the other in pure forest of *chir*-pine.

In both, the regeneration is the result of seeding fellings under the uniform system.

In both, the young crop is remarkably uniform and occurs over an extensive continuous area.

In both, the regeneration has an average height of about 15 feet and final fellings have been completed.

THE OAK AREA

There are very extensive oak forests in the hills of the United Provinces and where they occur in the neighbourhood of towns and cantonments they are intensively managed for the production of fuel and charcoal. For this purpose the system which naturally

commends itself is a system of simple coppice or coppice with standards. For several reasons, however, the forests are often not in a condition suitable for the adoption of a coppice system. One reason is the large number of ancient decrepit trees and lack of sufficient younger stems capable of coppicing. A system of group selection has sometimes been adopted in recent years but formerly a pure uniform system was tried in several places. The uniform system for oak was generally considered to have been a failure and fell into disfavour. The following example from the Mukteswar forests of Kumaon is a notable exception. (See Plate 25).

The forest occurs between 6,500 and 7,500 feet. *Ban* oak (*Quercus incana*) and *tilonj* (*Quercus dilatata*) are intimately mixed but the latter predominates at the higher altitude whilst the *ban* is commoner on the lower altitudes and in exposed situations. There are the usual broad-leaved associates of oak, chiefly rhododendron and *ayar* (*Pieris ovalifolia*). The forests were put under the uniform system in Smythies' Working Plan of 1917. Ten years later, first seeding fellings had been completed in three compartments over an area of about 200 acres. Results were then slow but quite promising. The revised working plan considered that "Regeneration, although abundant over most of the P. B. I. area so far worked, has not responded sufficiently to the fellings to permit much further reduction in the shelterwood as yet. The heavy growth of weeds and the injury which the crop has sustained due to defoliation by caterpillars and browsing by *sambhar* may have resulted in a somewhat abnormally slow development."

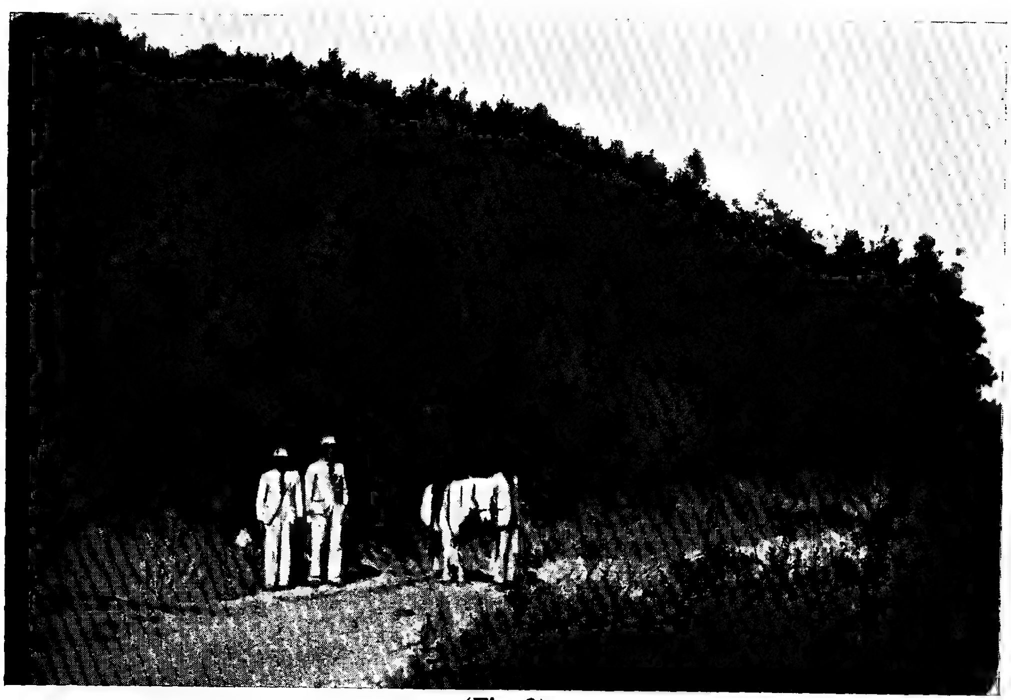
No further regeneration fellings were carried out in these particular compartments after 1928. Ten years later the silvicultural system was changed to Group Selection.

I saw the area for the first time in April, 1938, when the three compartments were still in the stage of a first seeding or second regeneration felling under the uniform system adopted in 1917. In my inspection note I wrote: "I have never seen such complete and profuse regeneration of oak. In fact I have rarely seen such profuse natural seeding regeneration of any species. Over this is standing an overwood of large scattered seed-bearers." Regeneration was for all practical purposes complete over a continuous area

Oak forest (mainly *Quercus dilatata*), Mukteswar, Kumaon. General view in 1917 of P.B.I. before regeneration fellings.

Photo by E. A. Smythies.

(Fig. 1)
Oak forest (mainly *Quercus dilatata*), Mukteswar, Kumaon. Final fellings completed. Dense young seedling crop about 15 feet high. (Unfelled forest in background and in right foreground.)



(Fig. 2)
Oak forest (mainly *Quercus dilatata*), Mukteswar, Kumaon. Dense young seedling crop, obtained by regeneration fellings under the Uniform System. Final fellings completed.

of 200 acres in which seeding fellings had been started only 20 years before. The average height was about 15 feet. Its density and the nature of the original crop precluded any possibility of more than a small fraction of the regeneration being of coppice origin.

I had no hesitation in ordering the immediate removal of the overwood. I saw the area again a few days ago. Final fellings have now been completed over most of the three compartments. So far it has not been found necessary to retain a single seed-bearer. Thinnings are being carried out in the more advanced groups where the stems have an average diameter of two to three inches and are providing an appreciable yield of small fuel. (Plate 26).

I have no fault to find with the silvicultural system of Group Selection now adopted but if any justification was considered necessary for the adoption of the uniform system in such a crop of oak, surely this example would provide it. The regeneration interval has been only 20 years and it has resulted in a very fine young crop. There is apt to be a tendency amongst us all to be too impatient of results under the uniform system, particularly when growth of the species under management is slow in the early stages of regeneration.

THE CHIR AREA

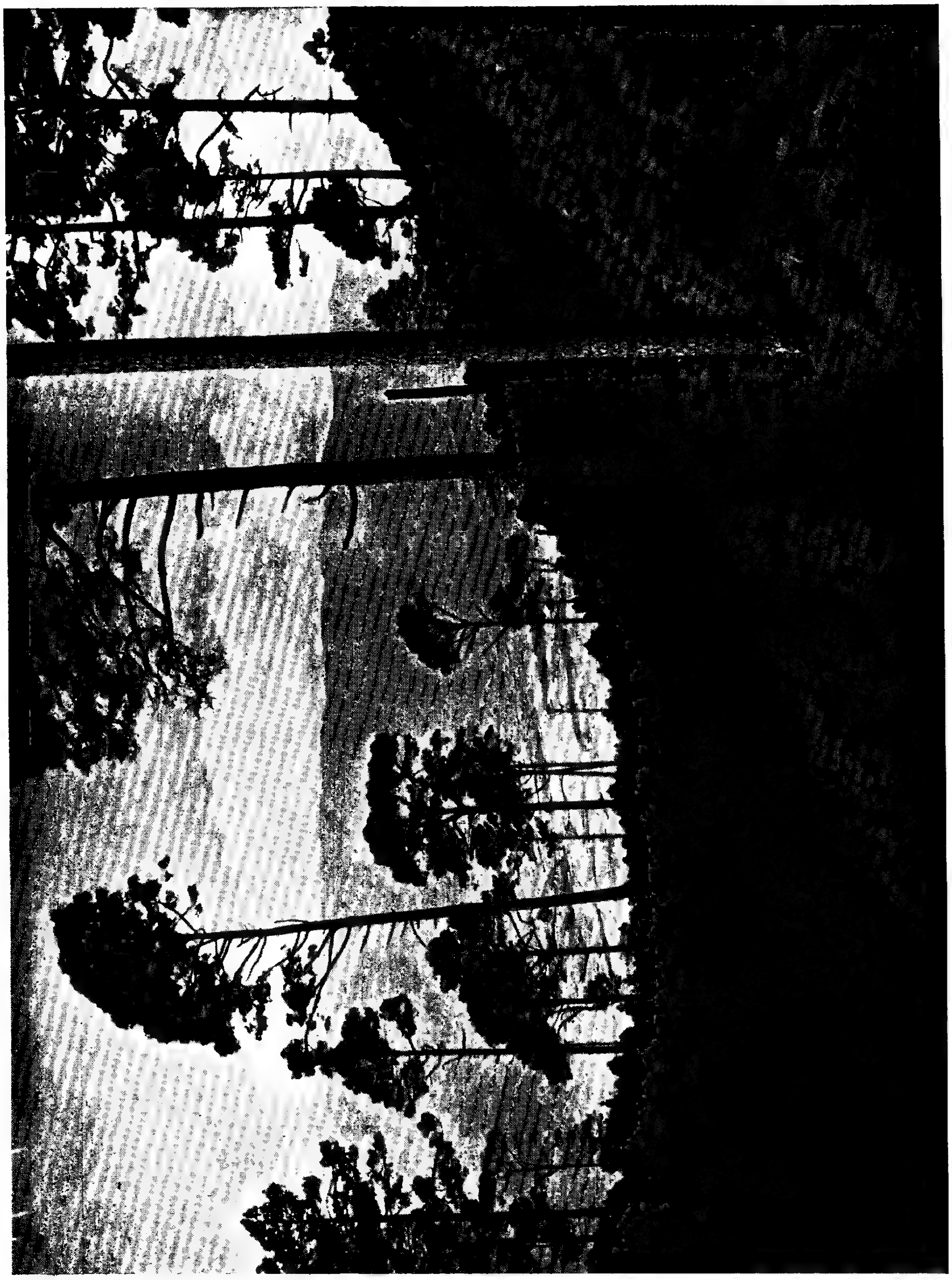
My second example is of interest in being one of the largest continuous areas of young natural regeneration from seed in India. It is situated near Garkhet in the South Khabdoli Block of East Almora Division. It covers a compact self-contained area of about 1,400 acres. Regeneration fellings were carried out between 1918 and 1924, leaving five to six seed-bearers per acre. I ordered final fellings to be carried out in 1932-33 when the regeneration was four to 10 feet high, about 80 per cent. complete, and generally very dense. A few seed-bearers were retained, sometimes unnecessarily, in small blanks in each compartment, and are being removed gradually by rightholders.

Actually the regeneration is the result of two different seed years, but the young crop now looks remarkably uniform. Such uniformity is not now aimed at. Advanced groups and even individual stems up to 16 inches diameter may be retained as part of the

future crop. Under certain circumstances, the nature of the regeneration fellings and the profile of the future crop under this modification may so differ from the accepted conception of the ordinary uniform system, that in the Punjab the modern system of management has been honoured with a special designation under the title of the Punjab Shelterwood System.

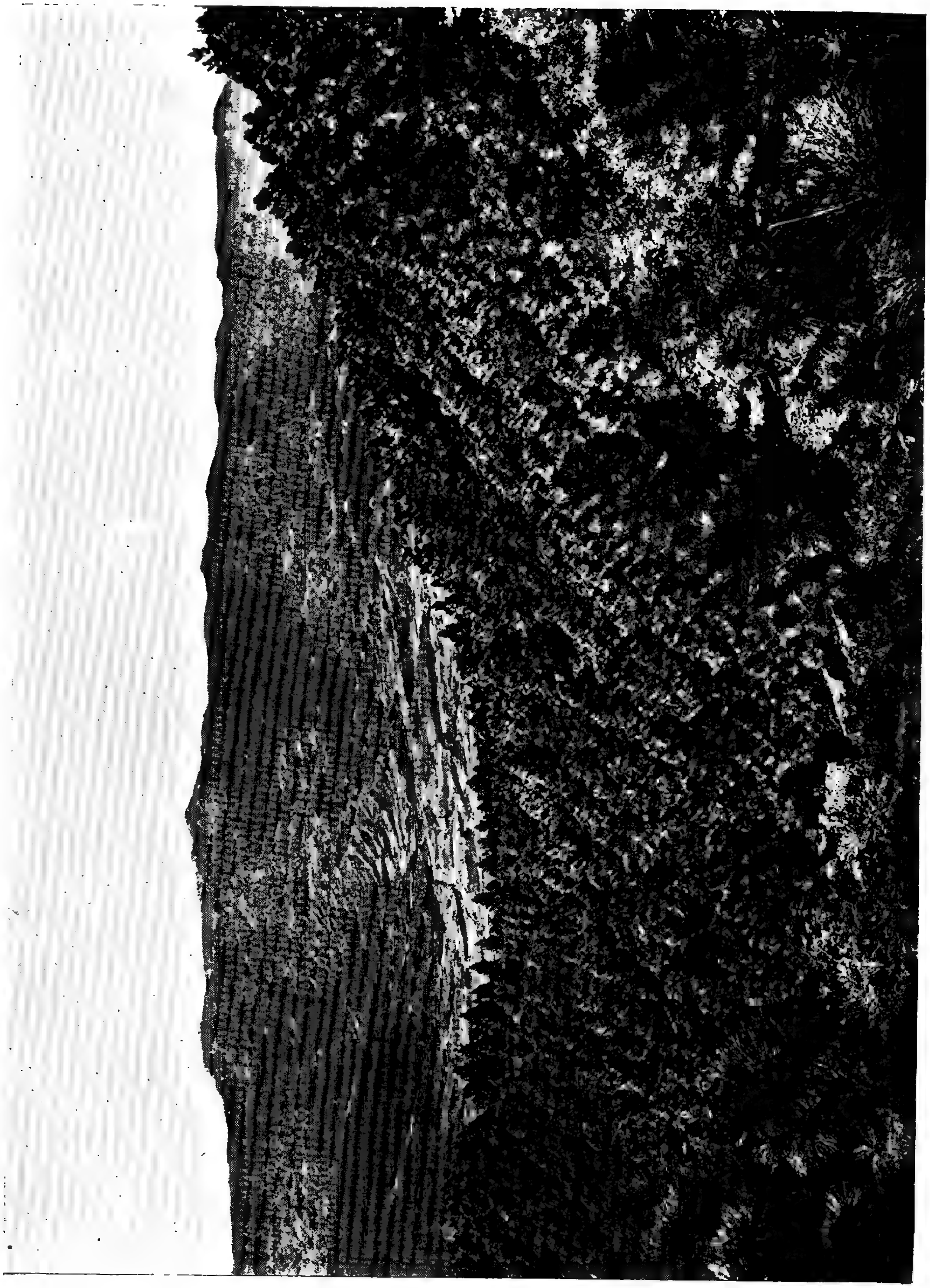
There is still considerable difference of opinion as to when final fellings should be carried out in *chir*. In the Punjab, where a minimum of eight seed-bearers per acre are retained in the first seeding felling and where a secondary regeneration felling is carried out, the question of when the final felling should be done practically solves itself or is at least rendered more simple. In the United Provinces, where only five to six seed-bearers are retained in the seeding felling and a secondary felling is dispensed with, I have seen areas where the final felling has been postponed until the future crop is in the young pole stage whilst in the case of South Khabdoli under report, the overwood was for all practical purposes entirely removed when the regeneration was in the young sapling stage. Present orders in the United Provinces are that final fellings *may* be carried out when the regeneration has been control-burnt for three consecutive years. Under the most favourable conditions, this means when the regeneration has a minimum age of seven years and a minimum height of about four feet. It would require courage to take the responsibility of carrying out the final removal of the overwood at so early a stage, on account of the fire hazard. In the case of South Khabdoli, special circumstances rendered it necessary to carry out the final fellings rather early. Working plan organisation, concentration of fellings and other considerations influence the decision but I am personally in favour of carrying out the final felling as early as possible after the regeneration has reached an average height of about 12 feet. (See Plate 27.)

Special considerations also affected the decision to fell most of the overwood in South Khabdoli in one operation. It would have been safer to have left at least two compartments as a buffer for a



Chir regeneration under a seeding felling, South Khabdoli C. 28. Photo taken in 1930.

Photo by H. G. Champion.



Chir regeneration, final fellings completed. Same view as Plate 27. Photo taken in 1933.

Photo by E. C. Mobbs.

later period until slash disposal after the final fellings in the remaining compartments had been completely finished and control burning resumed. In fact it would be very inadvisable to allot such a large compact area to P.B.I. at all. These final fellings produced over 34,000 broad-gauge sleepers alone and until the sawn timber was removed and slash disposal completed it was an anxious period for the staff. Considering the enormous damage that has been caused by fire to young *chir* regeneration in the Kumaon Hills during the last 20 years, it has been remarkable that such a large continuous area extending over seven contiguous compartments, unprotected by a single unallotted or unfelled buffer compartment, should have survived at all.

Fire protection is mainly achieved by annual departmental burning under control downhill during the cold weather after the regeneration is about three feet high, a system of fire protection which we learnt from the Punjab. Nobody likes it. It must have a bad effect on the soil. It was scoffed at recently by one divisional forest officer. But until we find some equally cheap and effective alternative we have no intention of giving it up. Fire lines are expensive to maintain and are useless by themselves.

In this enormous area of young regeneration in South Khabdoli a severe uphill fire occurred in June, 1935. If it had occurred six years before, the regeneration would have been wiped out. I saw the area in the following summer. Although I knew the area intimately only two years before. I did not suspect that a fire had occurred and could see no difference in the density of the young crop after the fire. Actually, it was estimated at the time that 5 per cent. to 12 per cent. of the regeneration had been killed in different compartments. I do not for a moment question the estimate. I only wish to emphasise that a severe uphill fire at the hottest time of the year did little permanent damage to this young *chir* crop. Surely this is excellent testimony to the effectiveness of control burning as a system of fire protecting young *chir* regeneration, however one might criticise it on other grounds. (See Plate 28).

SOIL CONSERVATION BY TERRACING AND GRADING

By G. W. D. Breadon, M.I.C.E., A.I.S.A., etc.,

District Engineer, Gurdaspur, Punjab.

The Value and Uses of Vegetation on Land.—Forests of trees and shrubs are the natural covering provided for the protection of soil. Remove these and the land is exposed to destruction by rain. Rivers are the channels for the conveyance of water from their catchment areas to the sea or lakes. Under normal conditions most rivers are perennial and, as such, they are not subject to sudden heavy spates—this is one of Nature's most wonderful regulations brought about through the medium of plant life.

Vegetation not only breaks the force of rain by intercepting it before it reaches the soil, but enables the soil to absorb the water and to pass it downwards to the subsoil and storage reservoirs, which are the chief sources from which streams and rivers are fed. Supply is thus regulated to a degree that will surprise most people, who will study perennial rivers in lands covered by virgin forests.

It is, therefore, of paramount importance that plant life on catchment areas should be preserved as it is of vital necessity and, where it has been unwisely destroyed, it should be replaced.

How Erosion is Caused.—Land that has been denuded of vegetation is land that has been deprived of all protective covering and rendered unfit to function as a storage area for water. Rain falling on the naked surface is able unrestrictedly to perform its diabolical work of erosion and in a short time to convert the region into a veritable geological shambles.

The Effects of Erosion.—Each drop of rain that falls on an exposed surface dislodges a portion of the soil lying on the surface. Soil washed out by rain is carried into streams and rivers and much of it taken on to the sea or lake into which they discharge, but unmeasurably enormous quantities of the heavier qualities are deposited on the river-bed and on the lands that are inundated during floods. The river-bed is thus constantly rising and the downward rush of a large body of water has perforce to create a wider channel for itself and also to meander in order to provide a lengthier path for the increased volume of water. This is but natural, for since velocity

cannot be increased unless the gradient is altered, the only alternative is a wider channel and a longer winding course with constant alterations, which cause destruction to both land and villages, often to towns as well.

Shortage of Water for Winter Irrigation.—The Irrigation Engineer has transformed wildernesses into productive areas by means of canals, but in many places he is now facing a very serious problem of winter watering and, with progressive denudation of forests and increasing deterioration of land under erosion, it is not unreasonable to predict that the time is not far distant when the very existence of irrigation farming will be endangered.

Comparison of Discharges over Forest and Exposed Lands.—It is very difficult to correctly estimate the difference between flood discharges over land denuded of vegetation and the normal flow of water over forest areas, but from observations made over a number of years, I should say that the proportion is 200 to 1. The sinister results of deforestation and unrestricted grazing surpass description.

Water-Logging.—Flooding too results in the raising of subsoil water, very often referred to as the water-table. This is another problem that we have to face. Its cause can be traced back to the evil hands that uncovered the catchment areas of our rivers.

Kinds of Soil-Erosion.—Speaking generally soil-erosion takes place in two ways at one and the same time. Rain falling on the surface of the land softens the soil and disintegrates it. Of its component parts the finer particles, which are the easier removed by flowing water, contain the richer essential plant-foods—such as potash, nitrogen and phosphoric acid—and their removal impoverishes the soil, although the harmful result might not be detected for some time. This type of erosion may be correctly designated "Wash Erosion." The next is the "Scouring Erosion" that casts out channels for itself and forms drills, furrows, *nullahs, gullies* and ravines. On gentle slopes Wash Erosion accounts for the removal of surface soil to the extent of about a quarter inch per annum, whereas on steeper grades the loss is very much higher. Nature's process of soil-formation is slow while, on the other hand, its destruction can be accomplished in a very short time.

Erosion Control.—The question now is, "How can we effectively and economically control erosion?" The answer is simple and short—Terrace the land and resort to reafforestation, but it must not be supposed that land that has been under erosion for a long time can be brought under the plough at once.

Terracing.—For cheap and efficient terracing tractors, graders and other mechanical tools are essential and some manual labour has also to be engaged. It is, of course, understood that terracing with mechanical tools cannot be done in difficult hilly country, but in the foothills and on undulating ground they can, with advantage, be employed.

Procedure.—In the first instance the engineer shall have to make a reconnaissance survey of the area to be terraced, noting the classes of soil, the slopes, natural water channels and the like on a contour plan and sub-dividing the area into terracing compartments between main water-escapes. The slope of the ground will determine the vertical drop from terrace to terrace, and the class of soil will determine the size of the terrace drain. On clay soils, which are more or less impervious on an unbroken surface, the run-off is rapid, and therefore, more water has to be carried, whereas on sandy soils, where absorption is greater, the quantity of water for removal is less. A ditch 10 to 11 feet wide and a foot deep, with an 18-inch high windrow on the lower side of the slope, will be large enough to meet ordinary requirements in the Punjab on the harder soils, and, since trench-terracing does not prevent the cultivation of land under the trench, there is no need to reduce the size of the trench on other classes of soils. Theoretically, of course, the trench ought to be smaller.

The first trench should be laid out along the top of the slope of the terrace compartment, which is the area between two main gullies running down the slope. Trenching should not be resorted to on land which has a greater slope than 10 feet in 100 feet. When the compartment is wide it is advisable to drain the water in both directions to the gullies forming its boundaries. In the case of smaller compartments the drainage may be carried in one direction only if so desired.

The average gradients to which trenches should be laid out are:

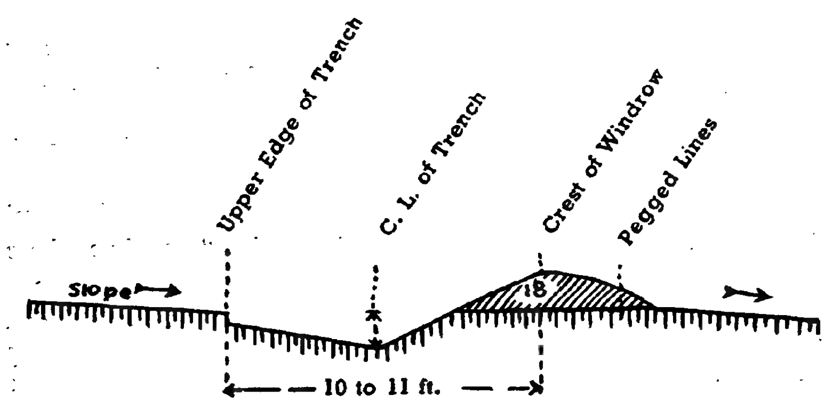
On clay soils: 3 inches per 100 feet fall.

On sandy soils: 2 inches per 100 feet fall.

but the trench in the middle of the compartment from which the ditches fall away on either side should be level for a distance varying from 200 to 400 feet according to the slope of the ground—the shorter length is for a steep slope and the longer for a gentle slope.

The smallest vertical fall between trenches on ground that has a slope of 1 foot in 100 feet is about 2 feet 6 inches and as the slope increases add 3 inches to the vertical distance for every foot per 100 in the slope, *i.e.*, for 2 feet per 100 slope the drop from one terrace to the other will be 2 feet 9 inches and for 10 feet per 100 slope the fall will be 4 feet 9 inches. The surveyor will, of course, use a level for laying out the trenches and for determining the distance between the trenches. For the guidance of the tractor-driver stakes should be placed along the line of trench 100 feet apart.

Forming the Trenches and Windrows.—After the surveyor has pegged out the guide line the work of the grader begins. The duty of the operator is to form a V-shaped ditch 10 to 11 feet across with a depth of one foot running at a distance of 10 feet from the line of stakes and forming a windrow about 18 inches in height on the lower side of the slope. It will take a No. 7 Adam's Leaning Wheel Grader with a 7-feet cutting blade, eight cuts to complete the trench and mound, which should look like the sketch given below when finished:



NOTE.—On slopes with a greater fall than 10 feet in 100 it will be necessary to build higher mounds and to reduce the distance between terraces to 40 feet or less according to the grade. Narrower

and deeper ditches should be cut to occupy as little land as possible for such ditches and mounds cannot be cultivated.

Trench Outlets.—When the entire compartment has been terraced the Engineer-in-charge should inspect each trench and level carefully and have all defects removed by cooly-labour. The construction of outlet drains for discharging water into natural gullies should also be taken in hand. If stones or timber be available the sides and bottom of outlets should be lined, otherwise fascines should be used. Banks across small intermediate gullies should be strengthened and the slopes pitched to prevent breaches. In short, everything ought to be done to make the terracing as strong and as permanent as possible.

Maintenance of Terraces.—When the agriculturist realizes the great benefits derivable from terracing he will himself take care of the work, but from the onset he ought to be taught how to maintain the ditches and windrows in good condition. In my opinion live fences of Ipomia carnea or some other shrub should be planted on the mounds, which should be raised at each ploughing, when the drains should also be cleaned. He should also attend to the repairs of outlets.

Cost of Terracing.—It is estimated that the cost of terracing on moderately hard soil in the Punjab should not exceed one rupee per acre, or twenty to fifty times less than manual labour. At this low rate reafforestation on an extensive scale falls within the bounds of possibility. The poorest of *zemindars* also will not find it beyond their means to join a co-operative society for the improvement of their lands.

In my humble opinion soil conservation ought to take precedence over any scheme of irrigation expansion.

The Increased Value of Terraced Land.—From an agricultural point of view an acre of terraced land is worth more than three acres of unterraced land. As time goes on its productivity increases, while production falls each year on land that has not been terraced.

As long as terraces remain intact the soil is conserved and gradually becomes enriched, water is absorbed into the soil, while the surplus is gradually discharged into the natural gullies. In this manner terracing alone exercises control over discharge to an appreciable degree.

The Forest Officer by planting up all available land in the catchment area and exercising control over grazing, and the Agricultural Officer by advising the cultivator what crops he should grow in rotational order, so as to keep his fields covered as long as possible, particularly during the monsoons, when heavy rain does most damage to the soil, will both render very valuable service in checking both classes of erosion. It requires the combined services and the close co-operation of the Engineer, the Forest Officer and the Agricultural Officer to fight against the ravages of erosion.

Terracing in actual practice in the Shakargarh Tehsil, Gurdaspur District.—In 1939 an area of about 50 acres near Fathu Chak, in the 4th mile of the Shakargarh-Ikhlaspur Road, was terraced, but subsequently "Watt-bandi" work was conducted between the terraced compartments and the demonstrational value of the plot *as a terraced area* was detroyed.

Consequently a second area in Halka No. 35 Dinpur and Halka No. 110 Shakargarh, quite close to Shakargarh town, was selected and terraced on the understanding that it will remain exclusively as a grader-terraced area. It comprises 402 acres all in one block. The work was performed by a T-20 Tractor and a Stockland Grader in 24 days and the total expenditure incurred, including depreciation, establishment charges, surveying, plotting and laying out the lines, amounted to Rs. 500, averaging, say, Re. 1/4/- per acre, which is four annas per acre in excess of the estimated cost of one rupee given above. This increase is due entirely to the higher prices now charged for fuel-oil, lubricants, etc., used by the tractor.

Since the completion of the work we had two heavy falls of rain and I have pleasure to record the fact that no defect in the scheme was noticed. I am satisfied that no further erosion of soil will take place and after gully-plugging has been done much reclamation of land will occur.

All interested in soil conservation by terracing with tractors and graders are invited to inspect the area. I am certain that its efficiency will be recognised and the low cost at which such efficiency can be attained will also make its appeal to all.

OCCURRENCE OF *HOPEA PARVIFLORA* IN HONAVAR RANGE, BOMBAY PROVINCE

BY S. S. DHARESHWAR,

Range Forest Officer, Honavar.

The Discovery of the Species.—During November, 1939, while inspecting Coupe 12-XII near the foot of the Malemane ghaut, three miles from Gersappa, the writer of this article was shown by the agent of the coupe contractor two logs that he prepared out of a tree which the latter could not identify. He called it *Kaygirgi*—a local name (which is, of course, a misnomer in this case) chiefly applied to one of the *Dysoxylums*. The species in question was suspected to be *Hopea parviflora* by the writer who had seen it before in flower and fruit during the year 1938 in South Kanara, the adjoining district of the Madras Province, and he had, ever since, been attempting annually to introduce it locally by importing its seed and seedlings from South Kanara. On further inspection, three more trees of this species were found in the vicinity besides a few pole-size stems, all of which, except two, were already felled by the contractor. The two standing trees were, however, reserved as seed-bearers. One of the felled trees measured 85 feet in height, having a clear bole length of 48 feet and a B. H. girth of 11 feet. Occurrence of this rare species suspected to be *Hopea parviflora* was reported personally to the Conservator of Forests, Southern Circle (Mr. W. C. De C. Walsh) when he visited Malemane Forest during December last and he was pleased to direct undertaking further search for the species. The leaf and wood specimens were then sent to the Forest Botanist, Forest Research Institute, Dehra Dun, for identification. The leaves having been probably not similar to the specimens available in the herbarium at Dehra Dun, the panicles and fruits were required by the Forest Botanist (plate 29). On examining the panicles sent from here, he gave the identification as *Hopea parviflora* with a suggestion to give a revised

Panicle of Hopea parviflora. Figs. I to IV are young fruits.

description of the leaf as the species is a new record for Bombay. The description is as follows:

LEAF: Cordate or subcordate at the base, glabrous above and paler beneath. At times obtuse, margin undulated. Ovate, apiculate or bluntly acuminate. Midrib strong and rather *tomentose beneath.* Lateral nerves prominent beneath, six to 12 pairs, opposite or sub-opposite. Axillary glandular dots are distinct at the junction of lateral nerves with the midrib. These glands are not very distinct above. This peculiarity of the leaf can be noticed even in the case of seedlings. Blade two to $3\frac{1}{2}$ inches by one to $1\frac{3}{4}$ inches. Petioles about .6 inch long, grooved above.

In young leaves the base is rounded.

SEEDLINGS, FLOWERING AND FRUITING: Same as described in Troup's Manual of Silviculture, Vol. I, page 49.

Habitat.—Further inspection of the Shiravati Upper Valley showed that the species grows best on the slopes flanking the river, above Gersappa, up to the Mysore Frontier. The growth is rather sporadic and the groups vary in extent. Trees about a 100 feet high having straight cylindrical bole-length of about 70 feet and, girth as much as 12 feet have been noticed on the lower slopes and even at an altitude of about 1,000 feet or 965 feet above the river bed. These tall trees are found to grow within about eight feet of each other evidently on account of their conical crowns. The largest group that was noticed consisted of about 20 mature trees. The rainfall in the locality may be as much as 200 inches or more. The forest is pure evergreen typical of the Sahyadris, often yielding place to semi-evergreen having a good mixture of the deciduous species to form the top storey. The chief associates of *Hopea parviflora* are *Hopea wightiana, Diospyros* spp., *Artocarpus hirsuta, Knema attenuata, Sageraea laurifolia, Strombosia ceylanica, Carallia integerrima, Alstonia scholaris, Calophyllum elatum, Trewia nudiflora, Vitex altissima, Lagerstroemia microcarpa, Garcinia cambogia* and *Gar. malabarica* particularly on the lower slopes up to the river bank.

Silvicultural Characters.—It is a hygrophilous species and is said to be a heavy shade-bearer in its youth, which fact is borne

out by the result of artificial regeneration attempted in the past two years. The species does not seem to coppice which is evident from the unresponsive stumps of the trees felled on permits in the past. The rate of growth according to Troup is rapid although it is rather slow in the first five years or so. Being a species of economic importance and a rare find having a limited distribution, it is proposed to tend the natural regeneration below the parent trees and also to pursue the attempts at artificial regeneration.

Natural Regeneration.—The seed production seems to vary from year to year as is evidenced by the nature of the seedling crop below the parent trees. In places closely shaded by thick canopy, the natural regeneration is poor. Thick, undecomposed leaf litter may be a hindrance to germination, especially in badly drained damp situations which foster toxic conditions in the soil. The seed does not retain its vitality for more than a few days and this factor deserves due notice in order to ensure a successful seedling crop. On inspection of the locality, it is found that sapling regeneration is not commensurate with the number of one or two-year-old seedlings that exist on the floor below the parent trees. This is obviously due to overhead shade and suppression. Sapling regeneration is, however, more abundant below the trees on the left bank of the river. Several age classes are also represented in the crop.

Silvicultural Treatment Proposed.—This is outlined as follows:

(*i*) *Coppicing* does not seem possible.

(*ii*) *Tending natural regeneration below parent trees.*—This is the easiest, practicable and the cheapest method of propagating the species which is now found mainly confined to difficult situations.

Natural regeneration is, however, found in varying degree of density. For instance, it is already adequate below some of the parent trees, or poor but likely to increase with improved conditions, or does not exist at all. For the present, the scheme is to take up as an experiment a group of four trees falling under each of the above three categories and do the tending. Briefly described, the work involves clearing all undergrowth within a radius of about a 100 feet below the parent trees that may interfere with the regeneration and lightening the canopy over it from below working gradu-

ally upwards as the regeneration responds to the treatment and also soil wounding and even burning the debris where necessary with a view to removing the toxic conditions. Perhaps weeding and tending will have to be continued for at least three years in order to get the regeneration well established. All *Haiga—Hopea wightiana*—in the vicinity would be girdled as its seedlings bear so close an affinity to those of *Kiralbhogi—H. parviflora*—that they are practically indistinguishable from the latter. *Haiga* besides is more prolific in its reproduction and such a species in the neighbourhood would tend to be a definite check on *Kiralbhogi* regeneration. *Haiga* is not a favourable timber either and, though good, is a prohibitive fuel in difficult situations.

This method of treatment may induce the otherwise sporadic species to grow gregarious and form its own groups around the mother trees. The groups can then be gradually joined up and thus the species established over wider areas.

Artificial Regeneration.—Prior to the discovery of the species here, artificial regeneration was tried by importing eight to 10-week-old seedlings from South Kanara during the year 1938 without appreciable success. It appears to have also been tried once or twice prior to 1936 with the same result. The species being highly hygrophilous, the transplants did not thrive in the clearfelled and burnt areas. Fresh seed was obtained from South Kanara at the end of May, 1939, and sown immediately in nursery which was watered daily till the advent of rain. The result of germination was about 50 per cent. One-year-old seedlings were also imported from South Kanara and introduced in the regeneration areas. The survivals now number about 80 and are two years old. Stump planting was found unsuccessful. Dibbling and broadcasting under shady conditions may give better results than transplanting. The indigenous trees would supply the annual seed and seedling requirements and this is the main object in proposing protection and help to the natural regeneration. This species would also be a worthy substitute for teak to be introduced artificially in the congenial parts of the regeneration areas that lie within the limit prohibited for teak plantations in pursuance of the recent Government Resolution.

(*To be concluded.*)

REVIEWS AND ABSTRACTS

ELEMENTARY FOREST MENSURATION

By M. K. R. Jerram, M.C.

[*Pp.* x + 124. *Thomas Murby & Co., London,* 1939. 8*s*. 6*d*.]

This is an interesting little book which covers almost all the aspects of the subject in a concise and up-to-date and, at the same time, a very readable manner.

After introductory chapters on the history and theory of tree measurement, the measurement of felled and standing trees and their outturn are dealt with. This leads to the preparation of volume tables and the determination of increment of single trees and of whole woods. Yield tables are then dealt with and the last chapter, contributed by R. Bourne, is on the Measurement of Forests. Various tables have been given as appendices and, to finish with, there is a short appendix on the use of graphs.

The term "elementary" is used in the title because certain subjects, which are of interest chiefly to the specialist and the research

worker, are dealt with only very briefly. Sufficient is said, however, to give a clear idea of most of the modern developments of the subject, without going deeply into theories or research practice, and to explain the meaning of such terms as *form quotients* and the method of preparation and use of such things as *stem taper graphs* and *form class volume tables.*

In some cases the treatment is, if anything, too brief, and one wishes for more, written in the same clear style, while there are one or two matters omitted altogether, which might usefully have been included. Thus no mention is made of diameter tapes, which are commonly used in parts of India, no mention is made of "Top Height," a term now familiar in Indian forest statistical publications, and nothing is said about "Stand Tables."

While recognising the importance of sampling and other statistical processes in forest mensuration, and therefore of some knowledge of the science of statistics, the author has intentionally omitted this as being more particularly required by research workers, and out of place in a book of this nature. The maximum number of samples which can be taken in any particular case is considered to depend primarily on economic considerations, and intelligence in the selection of samples to be more important than the ability to apply a mathematical test to the adequacy of their number. In practice, however, economic considerations are not always the important factor. Forest Officers are often faced with the question of how many observations to make for the determination of some relationship or factor, and experience shows not only that opinions differ very widely as to what constitutes an adequate number of observations to give a reliable average, but also that often very unreliable conclusions have been drawn from inadequate data, when additional data could quite easily have been collected. A short section on this and related matters might, therefore, have been very usefully included. As it is, the only attempt in the book to apply statistical analysis to a set of observations is in the last appendix on *The Use of Graphs,* where the calculation of the average net deviation and its application to a curve as a whole is open to objection.

The more elementary parts of the book have been ably written in a clear and concise manner. But the student, for whom the

book is written, might again often wish for more detail. Thus, in dealing with height measuring instruments, although Christen's and Weise's hypsometers are illustrated and described in some detail, there is but brief mention of Brandis' and Smythies' dendrometers and the Abney Level and other forms of clinometer. Probably the Brandis and Abney instruments are the commonest in use in India, and brief descriptions of these and some of the other instruments, including the principles of their action in measuring angles, together with a few diagrams of the instruments, might have enhanced the value of the book to students.

In dealing with diameter measurements, an outline sketch of a calliper is given, but no detail of its construction, and in the text it is simply stated that "many different makes of calliper are in use varying . . . in the method used for ensuring that the movable arm shall be parallel to the fixed arm, when the measurement is taken, and yet shall not stick on the rule." In India, at any rate, callipers are usually made locally, and it is of the utmost importance to the Forest Officer to know just how the movable arm should be made. A very brief mention of the simplest methods, with illustrations, might again have been very usefully given.

In dealing with taper, the conventional geometric figures, parabaloid, cone and neiloid, are given, and it is shown that both the Smalian and Huber's formulae are correct for the parabaloid, and that in practice it is assumed that a stem or log has the form of a truncated parabaloid. No mention is made, however, of the consequences of applying these formulae to logs or trees which are conical or neiloidal in shape. It would have been a simple matter to show, or at least it might have been stated, that Huber's formula gives too low a value and the Smalian formula too high a value for these figures, the error of the Smalian formula being twice that of Huber's formula.

Some further details and hints for practical work in the field might also have enhanced the value of the book to students, for instance, regarding the conduct of enumerations generally and of partial enumerations, and the use of a trailer tape. For the latter, the student is referred to the United States Government "Abney Level Handbook," which may not always be easily obtainable.

Such additional information would probably have increased the size of the book to beyond the limits the author desired, but the book is, in any case, small, and the addition of a few extra pages would not have made it cumbersome and would have greatly increased the utility of the book to the student.

Despite these criticisms, which are, after all, minor points compared with the book as a whole, students, instructors and practising foresters alike will welcome it as a valuable addition to the literature on Forest Mensuration, replacing and bringing up to date the Mensuration section of Schlich Volume III, which is now out of print. The book will appeal especially to the practising forester looking for something clear, concise and readable to bring his knowledge up to date.

E. C. M.

"ASCU" WOOD PRESERVATIVE

I have read with interest your two articles on the above subject in the January and February issues of your *Journal*. I am extremely glad to hear that there is "widespread interest" in the difficulties encountered with this wood preservative, and some good will have been achieved by this publicity if the attention of Ascu users has been drawn to the fact that the *Ascu Record* has been withdrawn pending republication in a revised form. I would, however, like to draw your attention to the fact that the reason for its withdrawal were clearly stated in the note announcing its withdrawal, and this correspondence appears to have arisen chiefly because in your editorial of January, 1940, you were not able to publish the note in full.

The most important point connected with the withdrawal seems to have escaped your notice and also that of your correspondents. It is that the withdrawal was necessary, not so much as the result of the large-scale failures with Ascu-treated poles in North India, *but in order to prevent such failures in future.* The Forest Research Institute knows only too well that the failures in North India were due, in large part, to inadequate treatment, but it has not been made clear in your editorial that inadequate treatment might result from failure to evaluate intelligently some of the information given in the *Ascu Record.*

From some of your remarks it would appear that this Institute has already condemned Ascu *in toto*. This is a totally incorrect conception of the present position. What we are trying to do is to prevent future users from repeating the mistakes which have been made in the past, and if these mistakes were due in any way to some of the information given in the Ascu Record, the only safe procedure was to withdraw the *Record* for revision and thereby help to prevent further mistakes being made.

You say in your editorial for February, 1940, that, "the withdrawal of the *Ascu Record* at this stage leaves the users of the process in a very difficult position." I am unable to agree with this contention. All users of the preservative are, I hope, sufficiently intelligent to realise that inadequate preservative treatment is false

economy, and in the withdrawal notice we clearly indicated what we considered to be a reasonable and at the same time an adequate treatment. This information, as was stated in the withdrawal notice, is based on an assessment of the information available up to the present time. The users of Ascu should, therefore, find themselves, not in a "difficult position," but in a much safer position than they were formerly, and should, on the whole, be pleased to have some more reliable and more up-to-date information to work on than that given in the *Ascu Record*. The readers of your Journal will be the first to appreciate that no invention or process can be good for all time, and that modifications are bound to be necessary as experience accumulates. The Forest Research Institute has always made it clear that the final word on Ascu had not been spoken, but one or two illustrations relative to the present discussion will perhaps make the reasons for the withdrawal of the *Ascu Record* for revision more clear to your readers.

The originator of the process mentioned in the *Record* that "any illiterate *mistri*" could work an Ascu-treating plant. This has been found by experience to be incorrect, and it was largely due to ignorance of the difficulties encountered in practice in obtaining adequate treatment that the North Indian pole failures occurred. One of these difficulties (not mentioned in the *Ascu Record*) is that connected with the changes, both in composition and concentration, which take place in Ascu solution as the result of wood coming in contact with it. These changes vary with different species and, with some species, have been found to be very considerable, with the result that the composition and concentration of the treating solution in the service tank may be entirely changed after one treatment, so much so in fact as to make the old treating solution almost worthless. Again, the originator of the process recommended a treatment consisting of a fairly low pressure maintained for about 15 minutes. This treatment has been found to be insufficient in practice to obtain complete penetration and good absorption, even in the perishable sapwood of some species, and it is certainly not sufficient to obtain complete penetration and adequate absorption in the heartwood of several perishable woods. Other new factors, some of which are mentioned in the withdrawal note, have also come to light as the

result of experience. These new factors were not known when the Ascu Record was published, but the North Indian pole failures brought out the fact that they might be serious. They are not connected solely with inadequate treatment, but concern such features as the possible existence in India of arsenic and copper-resisting fungi, the possible adverse effects of certain soil conditions on Ascu, and the chemical changes of the toxic constituents of Ascu which may take place when it comes in contact with other chemicals present in certain species of wood.

Finally, allow me to make it quite clear that this Institute has not condemned Ascu or discarded it as worthless. This will be evident from the note, which is sent out to all enquirers who ask for information on Ascu. In the Forest Research Institute's opinion, Ascu is an interesting preservative which has certain features not always found in other preservatives, but it is a comparatively new preservative which is continually presenting fresh difficulties, and until these difficulties have been studied and are more fully understood, the Forest Research Institute cannot endorse its use indiscriminately. As soon as it was realised that some of these new factors might be dangerous, and as they were not known at the time the *Ascu Record* was written, it was considered advisable to withdraw the *Record*, and to issue it later in revised form, so as to avoid repetitions of large-scale failures such as those encountered in Northern India.

FOREST RESEARCH INSTITUTE AND COLLEGE, L. MASON.
DEHRA DUN:
March 17, 1940. —*Current Science, Vol.* 9, *No.* 4, *April,* 1940.

INDIAN FORESTER

AUGUST, 1940

PREMONSOON STUMP PLANTING OF TEAK IN UPPER GODAVERI DIVISION, MADRAS

BY M. V. LAURIE

Abstract.—Premonsoon planting experiments with teak root and shoot cuttings in Upper Godaveri Division, a dry locality with few premonsoon showers, show that best results are got by planting about three weeks before the break of the monsoon. This gives high survival per cent. combined with a 100 per cent. increase in first season height growth as compared with planting at the break of the monsoon.

The earlier researches which first established the advantages of premonsoon stump planting of teak in Madras were all done in a West Coast type of climate, and in publishing the results (*vide* Indian Forest Records, Silvicultural Series, Vol. III, No. 2), it was emphasised that the results only applied to such a climate. It was suggested, however, that under other climatic conditions similar advantages might be obtainable by premonsoon stump planting. The best date of planting for each locality would, however, have to be determined by local experiments repeated over a number of years.

The Silviculturist, Madras, has just sent particulars of the results of such a set of experiments carried out in Upper Godaveri Division, which has an entirely different climate from that in which the original experiments were done. Not only does the monsoon break nearly a month later (10th to 15th July as compared with 10th to 15th June on the west coast), but the premonsoon showers are fewer and lighter and confined to a shorter period, mostly falling in the last week of June and the first week of July. Negligible rain falls in April and May.

The experiments, which were carried out by the Divisional Staff in three different ranges and repeated over four seasons from 1935 to 1938 inclusive, consisted in planting sets of stumps at fortnightly intervals from the 15th April up to the 1st August. The experiments were laid out according to simple designs given by the

Provincial Silviculturist involving necessary replication and randomising of treatments. A brief summary of results is as follows (averages from replications in three ranges):

I.—SURVIVAL PERCENTAGE

Year of experiment	Stumps planted on							
	15-4	1-5	15-5	1-6	15-6	1-7	15-7	1-8
1935 ..	19	14	23	25	99	92		
1936 ..	16	21	59	96	95	88		
1937 ..	55	38	35	40	97	92	86	76
1938 ..	30	37	63	94	88	67	66	69
Average..	30	28	45	64	95	85	76	73

II.—MEAN HEIGHT IN INCHES

1935 ..	..	..	..	..	..	..	..	..
1936 ..	26·2	20·6	24·9	22·6	11·8	7·0		
1937 ..	30·9	24·4	21·3	20·6	20·4	9·3	6·3	4·3
1938 ..	23·4	26·4	22·6	20·7	14·2	7·1	6·1	4·9
Average..	26·8	23·8	22·9	21·3	15·5	7·8	6·2	4·6

Note 1.—In all four years of the experiments the monsoon broke in the first or second week of July.

2. Heights were not recorded in the 1935 experiments.

The conclusion to be drawn from the above figures is that the best date for stump planting in Upper Godaveri Division is on the 15th June, *i.e.*, about three weeks before the break of the monsoon —a date which gave a consistently high percentage of survivals combined with an increase in average height growth of about 100 per cent. as compared with planting on July 1st, and of more than 100 per cent. as compared with planting at the beginning of the monsoon.

The original west-coast experiments indicated the best date to be about six weeks before the break of Monsoon proper, but in this case the premonsoon showers, though small in quantity and often separated by two or three weeks' continuous drought, were spread over four to five weeks prior to the break of the monsoon. It is interesting to find that in the much drier climate of Upper Godaveri Division with less premonsoon showers, one can, with great advantage, plant teak stumps as early as three weeks before the monsoon. The results from year to year were also surprisingly consistent.

These investigations are a good example of how a divisional staff can, by carrying out a set of properly designed simple small-scale experiments, improve considerably their plantation technique.

NOTE ON THE TYPE OF FOREST OCCURRING IN THE HIGHER PARTS OF THE CENTRAL PROVINCES

By C. E. Hewetson

My attention was attracted to this by finding, when on tour in the Betul District, a type of forest different from any other I had seen in the Central Provinces. The characteristic was the occurrence of more of the evergreen species of these parts than usual. On consulting Champion's *Preliminary Survey of the Forest Types of India and Burma,* I found that he mentioned that a type of subtropical wet hill forest should be found at places such as Pachmarhi but that there was no description given of the trees occurring (page 195). During the last two years I have visited several of the highest localities in the west of the Central Provinces and give my observations which tend to shew that there is a definite type of forest found at the higher elevations; and that this type is different from the ordinary mixed deciduous forests of the plains. I have not been able to see the higher localities in the east of the province.

Unfortunately all these places at higher elevation have been the scene of human occupation and I could not find any forest which could be called undisturbed. The best example I have found is at an elevation of 2,700 feet only, at which elevation in

other parts the ordinary mixed deciduous forest association also occurs; so that this example is not completely satisfactory.

However, in all these remnants the same species are found and one can form a conclusion about the type of forest which would be the natural covering of these uplands. *Terminalia chebula* (Harra) is perhaps the most prominent species and the association may be called after this tree. That these uplands do enjoy a distinctive climate is also supported by the appearance of several birds. These are the red-whiskered *Bulbul* (*Otocompsa focosa*) and the Malabar Whistling Thrush (*Myophonus horsfieldii*). The Nilgiri Blackbird (*Turdus simillimus*) is also found at certain times though whether it is a definite migrant is not yet certain. The Indian Squirrel (*Sciurus indicus*) also occurs at Pachmarhi and on Killindeo plateau. This squirrel is not found elsewhere in the Province until one gets to the very south.

The places visited were Pachmarhi, Killindeo, Ladi, Kukroo and Chikalda in the Central Provinces. The climate is indicated by the following figures for Pachmarhi and Chikalda taken from Working Plans:

	Temperature		Rainfall
	Maximum	Minimum	
PACHMARHI—			
(Average of 5 years)	102°F.	36°F.	Varies between 64 inches and 107 inches.
CHIKALDA—			
Hot season ..	94°—102°F.	72°—80°F.	Average for ten years is 70 inches.
Cold season ..	66°—74°F.	46°—60°F.	

Round Pachmarhi a great deal of the forest is sal. It is a very scrubby type of 20 or 30 feet There are a number of interesting shrubs which do not occur elsewhere in the Central Provinces such as *Melastoma malabathricum* and *Murraya exotica*. The non-sal forest is generally very open and is too obviously changed by man to serve this enquiry. Ecologically speaking, the most interesting

feature of the plateau is the sharp contrast between the scrubby sal trees of the surface and the moist vegetation of the ravines. The streams have cut down into the sandstone forming gulleys of considerable depth. Perennial streams flow at the bottom of these gulleys and along their banks well grown specimens of tree ferns are found (probably *Alsophila glabra* and *Cyathea spinulosa*).

Killindeo is much drier than Pachmarhi and there are no streams running off the plateau. The vegetation of the flat top is very open due to past cultivation. However, cultivation has not occurred for fifty years at least, so I will give an account of the trees found. Owing to very dry soil a dense forest is not to be expected. A typical example contained 50 per cent. stocking and was made up of *Terminalia tomentosa, Pterocarpus marsupium, Careya arborea, Buchanania lanzan, Emblica officinalis, Albizzia odoratissima*; shrubs were *Helicteres isora, Indigofera pulchella, Embelia robusta Strobilanthes* spp., *Phoenix acaulis.* Climbers were *Acacia concinna* and *Bauhinia vahlii.* This is not very different from forest found at ordinary elevations in the Central Provinces. In this case the dryness of the soil has counteracted the altitude. Here and there the following less usual species also occur and suggest that a different type might arise if man's interference were withheld for a sufficient time.

Terminalia chebula, Anogeissus sericea (a doubtful identification), *Mangifera indica, Glochidion velutinum, Mimusops hexandra. Dillenia pentagyna*; and among shrubs *Rhus parviflora* and *Heptapleurum venulosum.* The last, a curious-looking plant, which suggests a survival from more primitive floras. An interesting point is that the variety of *Terminalia tomentosa* is very distinctive and is not the usual Central-Provinces form. It has a small, oval leaf with a dense white tomentum on the lower surface. The trees look silvery from a distance (vide Indian Terminalias of the section *Pentaptera,* C. E. Parkinson); this tree appears to come close to *Terminalia coriacea typica.*

On a precipitous slope covered with large boulders near the summit the tree growth was more varied. A spring started at this place. Along the *nala* were mango trees; *Eugenia jambolana, Dalbergia paniculata, Wendlandia exserta, Kydia calycina,* several

species of *Ficus, Garuga pinnata* and many other usual species. The understory contained *Dendrocalamus strictus, Casearia graveolens, Gardenia latifolia, Millettia auriculata* and *Helicteres isora.*

The forest found at 2,700 feet in Betul district (*vide* Plate 30, Fig. 1) is on soil derived from metamorphic rocks; and this soil is much moister than that derived from the sandstones of the northern plateaus or the trap-rock of the southern ones. The forest here is closed and has obviously not suffered from shifting cultivation for many years. There are a great number of species found:

COMMON SPECIES

Terminalia chebula, Terminalia belerica, Eugenia jambolana, Lagerstroemia parviflora, Albizzia ordoratissima, Emblica officinalis, Mallotus philippinensis.

LESS COMMON SPECIES

Ailanthus excelsa, Wendlandia exserta; Mangifera indica, Cordia myxa, Trema orientalis, Ficus glomerata.

Species usually found in the Central Province which also occur: *Miliusa velutina, Flacourtia ramontchi, Bombax malabaricum Kydia calycina, Schleichera oleosa, Lannea grandis, Ougeinia dalbergioides, Erythrina indica, Butea frondosa, Pterocarpus marsupium, Cassia fistula, Bauhinia retusa, Terminalia tomentosa, Anogeissus latifolia, Careya arborea, Casearia graveolens, Casearia tomentosa, Adina cordifolia, Randia dumentorum, Madhuca latifolia, Diospyros melanoxylon, Cordia macleodii, Ficus bengalensis, Ficus religiosa, Ficus infectoria, Ficus hispida.*

Undergrowth consists of *Colebrookia oppositifolia* (common), *Dendrocalamus strictus, Holarrhena antidysenterica.*

CLIMBERS

Zizyphus xylopyra and Bauhinia vahlii.

REGENERATION

Eugenia jambolana, Mangifera indica and *Trema orientalis.*

By reading the list of the trees one might not visualise a forest very different from that found in many parts of the Province but the appearance of the forest is completely different. This is due to the higher proportion of trees such as *Eugenia, Mangifera,* many

Fig. I.

Bairat (near Chikalda), 3,900 feet. Large tree in the foreground is a *Grewia*.

Forest at Ladi, Betul District, 2,700 feet. Illustrates dense undergrowth of *Colebrookia oppositifolia*.

Fig. II.

Ficus spp., *Trema orientalis*, and to the fact that most of the trees are green except for a comparatively short time. The occurrence of the commoner species is probably due to the lower elevation. Fewer trees can climb above 3,000 feet.

Round Chikalda itself unspoilt forest is not found but towards Bairat at an elevation of 3,900 feet some patches of closed forest do occur. While the forest last described is well grown and shews a normal appearance, the trees on Bairat are stunted and badly shaped (vide Plate 30, Fig. II). This is due to heavy mists in the monsoon and strong winds. The trees are thickly covered with moss and lichens. The floristic composition is similar but a few species are different.

I give a list of the trees noted by me, and a description from Mr. Stein's Working Plan of the Melghat:

Flacourtia ramontchi (f), Bombax malabaricum (f), Kydia calycina (f), Eriolaena hookeriana (f), Grewia orbiculata (f), Grewia tiliaefolia (tomentose form) (o), Ailanthus malabarica (o), Cedrela toona (o), Zizyphus rugosa (o), Mangifera indica (o), Lannea grandis (f), Ougeinia dalbergioides (a), Dalbergia latifolia (o), Cassia fistula (f), Albizzia odoratissima (f), Terminalia belerica (o), Terminalia tomentosa (r), Anogeissus latifolia (o), Eugenia jambolana (f), Careya arborea (a), Casearia graveoleus (f), Wrightia tinctoria (f), Stereospermum xylocarpum (o), Stereospermum suaveolens (r), Lantana camara (a), Pogostemon plectranthoides (f), Colebrookia oppositifolia (a), Litsaea sebifera (o), Euphorbia nivulia (gregarious on steep slopes), *Emblica officinalis (a), Mallotus philippinensis (f), Trema orientalis (f), Ficus infectoria (o), Ficus glomerata (f), Dendrocalamus strictus (r).**

I quote the description given in Mr. Stein's Working Plan for the Melghat. He recognised a definite type at the highest elevations which he terms the pure *Ougeinia dalbergioides* type. He gives as the associates *Emblica officinalis, Grewia tiliaefolia, Ziyyphus xylopyra, Zizyphus rugosa, Kydia calycina, Wrightia tinctoria, Ficus*

*ABBREVIATIONS.—(*a*)—Abundant. (*f*)—Frequent. (*o*)—Occasional. (*r*)—Rare.

glomerata, Eugenia jambolana, Terminalia chebula and *Careya arborea.* He notes that *Terminalia chebula* is not found on the plateau near Chikalda. This is the only locality in which it is absent.

He also gives a second type occurring at lower elevations but over 2,500 feet. *Ougeinia delbergioides* is still the most frequent species but the associates are reported to be more varied. In addition to those mentioned above the following less common trees are also found:

Saccopetalum tomentosum, Mallotus philippinensis, Bridelia retusa, Terminalia belerica, Cedrela tona, Mangifera indica, Cordia macleodii, Glochidion velutinum, Sterculia colorata, Stereospermum xylocarpum, Litsaea sebifera. The undergrowth contains *Colebrookia oppositifolia, Pogostemon plectranthoides, Solanum indicum* and many species which are also found in the plains.

Various species of *Strobilanthes* may be mentioned.

The conclusions to be drawn are:

(1) No tree species peculiar to the hills are found. All the trees which occur may also be found at the lower elevations. The distinctive feature is that the moisture-demanding species which at lower elevations are only found in the neighbourhood of *nalas* form a greater part of the crop; and here grow and regenerate naturally away from *nalas.* This is a great contrast to the usual vegetation on hill-tops at lower elevations where *Boswellia serrata, Lannea grandis* and *Sterculia urens* are the usual species and indicate a very dry habitat.

(2) The distinctive trees are *Terminalia chebula, Eugenia jambolana, Mangifera indica, Mallotus philippinensis, Trema orientalis, Ougeinia dalbergioides* (on the trap plateaus), *Careya arborea, Ficus glomerata* and several other species of *Ficus.* The distinctive shrubs are *Colebrookia oppositifolia, Pogostemon plectranthoides* and *Solanum indicum.* One or two distinctive shrubs are confined to the Pachmarhi and Killindeo plateaus. The evergreen species such as *Eugenia, Mallotus* and *Pogostemon* are the shrubs mentioned as occurring in the sal forests in the United Provinces (Smythies,

April, 1940, *Indian Forester*). It appears that these species represent the natural flora wherever the rainfall rises; they presumably also represent the type of flora that would occur naturally in the plains should the rainfall increase. Also wherever the conditions of the environment tend to become more mesophytic owing to successful fire protection and the establishment of a dense canopy these species will tend to increase.

(3) An interesting point and of considerable importance to the Forest Officer is that teak is absent. Apparently the teak tree does not grow naturally above about 3,000 feet; and certainly is less vigorous from 2,500 feet upwards.

THE CHOTA NAGPUR PRIVATE FORESTS BILL, 1939

By J. N. Sinha

It may interest the readers of the *Indian Forester* to know the outlines of the Private Forests Bill which is on the legislative anvil of Bihar. Private forests are being destroyed all over India. In Bihar a great step forward was taken when, as a result of an intense preaching programme, a few forest owners were persuaded to apply for preservation of their forests under Section 38 of the Indian Forest Act. But that section presupposes a background of appreciation of the benefits of forests, a wide outlook such as is rare. Most of the landlords applied because they could not get the better of the tenants who took away all the forest produce, right or no right. By leasing out the forest to Government, they argued, they would be assured of one anna per acre per annum and get half the profit when it accrues, while all the time Government would be spending their own money for management. Thus a considerable area came in for management. But there are others who, when approached, refused to apply. "We shall cut and sell our forest as we like," they said, "there is money in it. We want money. Who says the forest will disappear? It will not in our lifetime." The appeal of floods, of erosion, of the stark desolation that follows forest destruction—all this sounds too distant. They do not realise that ownership in forests has in no country been recognised as absolute, that most other countries of the world control their privately owned forest in

an intensive manner, and that the will of the individual must give way before the weal of the country. The result is that very large areas of forest are still subject to utter destruction. There are landlords who lease out a block of *sal* forest for five years at a time and throughout those five years the lessee cuts and recuts the coppice shoots as they grow. For paltry sums forests are given over to the axe for indiscriminate felling. Government, under the existing laws, have not the power to stem the destructive tide. They have done all that could be done, yet the situation is very largely unaltered.

Hence the new Bill to arm Government with wider powers to check forest destruction. Let me here quote from the "Statement of Objects and Reasons":

"It has been universally accepted that the preservation of forests is essentially necessary in the public interest and particularly in the interest of the peasantry. Government have been taking steps to preserve the forests which are their own property, but Government forests form a very small propotion of the total forest area of the Province.

The bulk of the forests which lie in Chota Nagpur belong to private persons, and they are being rapidly denuded by both landlords and tenants. The consequences are becoming more serious every year. The land from which the forest is cleared is nearly always unfit for cultivation; the soil is rapidly washed away, leaving bare rock; springs, wells and tanks dry up, cultivation is adversely affected and the climate itself changes for the worse. In the plains, floods become more severe owing to the denudation of the catchment areas.

With a view to preserving such private forests, Government adopted the policy of persuading landlords to apply under Section 38 of the Indian Forest Act, 1927, for the preservation or protection of their forests under the provisions of that Act, but the response so far has been very disappointing, and Government are convinced that the preservation of these private forests is not possible until the necessary legislative measures are undertaken, empowering Government to take over suitable private forests for management as protected forests. This Bill is intended to achieve this end."

Here is a brief summary of the provisions:

1. The Act will apply to the whole of Chota Nagpur Division.

2. It will not apply to the existing reserved or protected forests, or forests taken over for management under Section 38 of the Indian Forest Act. It will also not apply to those forests in respect of which records of rights have not been prepared.

3. All recorded rights, either of landlord or of tenants are to be exercised in accordance with the provisions of this Act.

4. A tenant may not cut or remove greater quantities of forest produce than are reasonably necessary for his own use. He must not cut above six inches from the ground level, nor young bamboos.

He may not reclaim land on steep slopes.

5. No landlord, nor any person who holds a lease of any forest from the landlord, may cut or remove forest produce to such an extent as may deprive the tenants of their reasonable requirements.

6. Tenants may complain to the Court of Law against a landlord who may contravene the above-mentioned restrictions, or the landlord may complain against tenants for similar contravention.

Any officer specially empowered by the Provincial Government in this behalf may also lodge a complaint.

Punishment for contravention is a fine not exceeding ten rupees for the first offence and fifty rupees, or imprisonment for one month, or both, for the second or any subsequent offence.

7. If the above provisions are not, or have not been sufficient to secure the due preservation of any forest, or if it is so necessary in the public interest, Government may, by notification, declare its intention to take over the management of any forest as Private Protected Forest.

Three months are allowed for interested parties to file objections against the proposal of constituting Private Protected Forest or preferring claims to compensation, etc.

Meanwhile Government may, by notification, prohibit or restrict the cutting or removal of trees.

After the expiry of the three-month period the Deputy Commissioner will hear objections and submit his recommendations to Government through the Commissioner.

Government may decide to take over management or decide not to.

Compensation may be given to interested parties for the extinction or modification of contracts that may have been entered into with them by the landlord before the notification mentioned above.

8. Private Protected Forest will be managed by Government on the lines of other forests under Government management.

The landlord will be allowed under regulation to take timber, etc., free of charge as may be reasonably necessary for his needs.

Tenants will be allowed to exercise their rights under regulation.

9. Government will receive all revenues and pay the whole expenditure incurred in the working and management of the forest.

All net profits accruing from the working and management of the forest shall be paid to the landlord.

The amount of any deficit shall be carried forward from year to year till such amount is made up and a surplus is effected.

Regarding control, penalties and procedure the provisions are almost the same as those contained in Chapters IX to XIII of the Indian Forest Act, 1927.

ROAD BRIDGE DECKING

BY J. L. HARRISON

Covered wooden road bridges are never seen in England or India, although they were common in the United States in days gone by. With the rapid expansion of communications in America, combined with the vast quantities of timber available at site, most of the road bridges and, moreover, most of the railroad bridges, originally were made of timber.

Wood has always been an outstanding construction material. When sound, it has great strength compared to its weight, it can be obtained in all sizes and, for construction purposes, can be readily cut and shaped. What brought about its decline for outside structures of the nature of bridges was, firstly, the lack of serviceability of some species and, secondly, the increasing traffic loads.

Timber has its limitations but, within these limitations, its strength compares very favourably with most structural materials. In the absence of data, produced as the result of organised well directed research, many of the formula formerly employed on timber designs were empirical and gave a much higher factor of safety than was required. In recent years, scientific research has emphasised the possibility of reducing the size of the various members of a structure, provided the natural deterioration, to be found in most timbers, could be arrested, or at least slowed up.

Much of the rapid deterioration of timbers in outside structures is due to weather conditions, with varying temperatures and moisture conditions. The markedly longer life of the normal species, when employed in an indoor protected work, as against its short life, if used in an outdoor structure, requires no emphasis. Preservative treatment effects an improvement but any exposure has a very marked deteriorating effect on the life of most timbers.

Various theories have been put forward as to why timber bridges were covered, including the suggestion of providing a refuge for courting couples in the rains, but it appears obvious that the real reason was not because of any beauty but to protect the understructure and particularly the decking and bearers. The long life of some of the old covered bridges in America and the soundness of many of the untreated timbers after as long as fifty to seventy years, bear witness to the efficiency of the protection given.

The decking for timber road bridges in India, and in early days in America also, consisted of timber of a thickness of four inches or more, laid transversely across the road-bearers. Over this decking, planking was laid to distribute the load better and also to minimise wear on the decking. The planking could be readily replaced. Provision has to be made in a decking of this sort for any surface water on the decking to be taken off and such was done by leaving narrow gaps between the lengths of decking and making drain-holes where required. Such was done but did not give adequate protection to the road-bearers.

With the increase in the use and quality of timber preservatives, with the lessening of available timber supplies and a corresponding increase in price and with the increase both as regards

volume and also weight of road traffic, some improvement was required and obtained in the normal life of bridge decking and framing generally.

The drawing Fig. 1 (Plate 31) shows one type of timber decking used in America for road bridges. The drawing is, I trust, more or less self-explanatory. The layer of asphalt laid between the upper decking two inches thick, and the lower decking four inches thick, prevents any rain or other surface water, which may fall on the bridge, from soaking through to the lower layer of decking or on to the road-bearers and top sills. It will be noted that a fillet of asphaltic cement is laid alongside the inside of the wheel-guards to prevent any seepage of water at such point. Provision has, of course, to be made for drawing off the water on the bridge roadway, and for such drainage, drain-holes or scuppers, as they are called, are constructed at suitable intervals alongside the junction of the decking and the wheel-guard.

With a decking of this nature, it is very necessary that the decking, upper and lower layers, should be securely fastened to minimise any vibration. With the upper layer of planking laid at right angles to the lower layer, any progressive cracks are prevented.

In America there are still many road bridges with single-plank floors. Where such construction is in existence and where the road-bearers and decking are sound, the wearing surface of the bridge can be improved by laying over the decking an upper layer of planking and, on top of such planking, spreading a surface of tar or asphalt. To lay a thick bituminous coat on a layer of single-plank decking would be somewhat unwise as, with such a construction, there would be an undue tendency for decking cracks to go right through the bituminous course and a single-plank layer of decking would be difficult to keep rigid. If any wearing surface were to be laid on top of a single-plank layer of decking, such would have to be a thin, pliable adhesive layer. Caulking would have to be done to any openings in the decking.

Where a wearing coat has to be applied to an existing bridge, the better arrangement would be as noted previously, to lay a light plank layer of decking above the present layer of decking. Over this upper layer, after a priming coat had been laid, the thick

TYPES OF DECKING FOR TIMBER ROAD BRIDGES

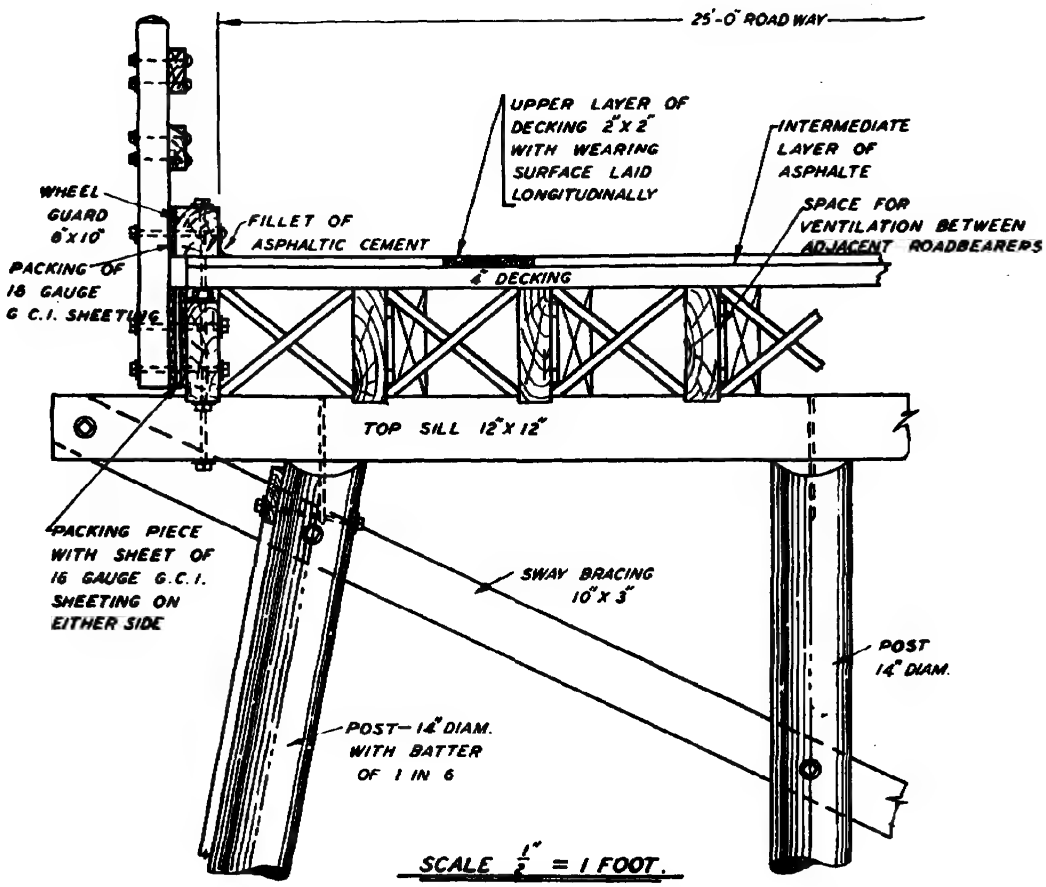


Fig. 1.

NOTE

DECKING 4" THICK IS LAID TRANSVERSELY ON ROAD BEARERS AND NAILED DOWN BY 8" SPIKES OVER THIS DECKING IS SPREAD A HEAVY MOP COAT OF HOT ASPHALT OR EMULSIFIED ASPHALT. WHILE THIS ASPHALT COAT IS STILL PLASTIC, A SECOND LAYER OF DECKING, 2" THICK, IS LAID ON TOP AND NAILED DOWN WITH 4½" NAILS THE UPPER LAYER OF DECKING HAS THE LENGTHS RUNNING LONGITUDINALLY

TYPES OF DECKING FOR TIMBER ROAD BRIDGES

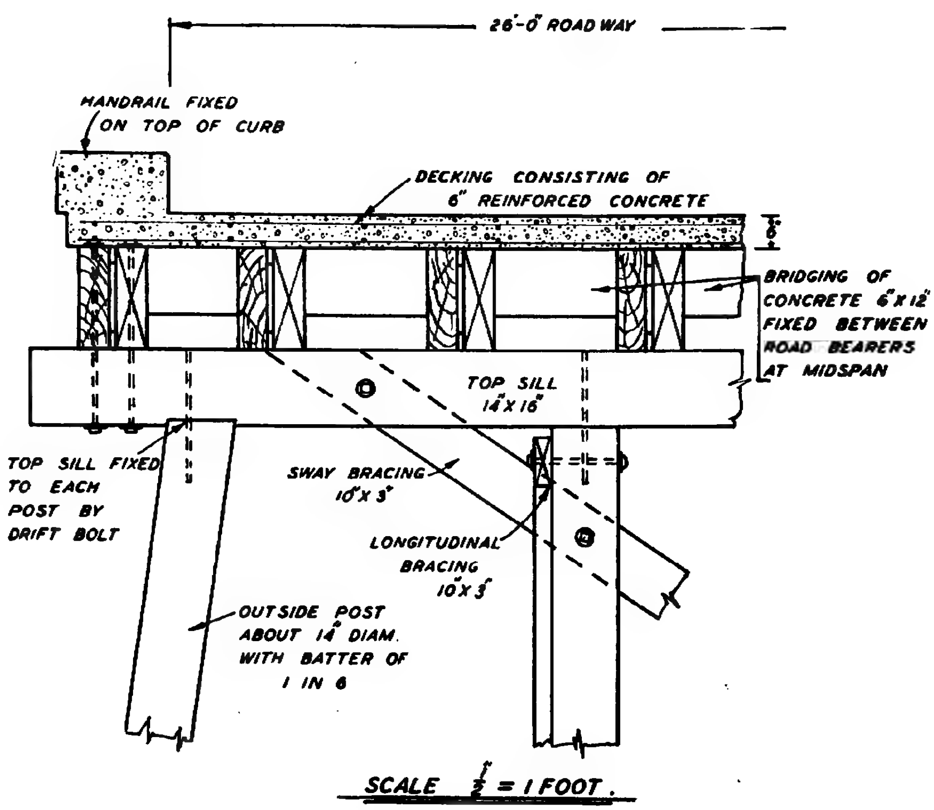


Fig. 2.

NOTE

In addition to the 6" concrete bridging between the Road Bearers at each midspan, there is wooden Bridging between the Road Bearers on each Topsill.

In place of a decking of two layers of timber, a decking of Reinforced concrete 6" thick is laid in this case.

The reinforcing consists of 1/2" steel bars.

Expansion Joints are fixed at every other Bent or as required.

Provision made for Drain openings in decking at intervals alongside Curb.

wearing coating of bitumen would be spread. The quantities required I do not know, but various authorities will have details of such treatment. Over the final bitumen coating is spread fine aggregate.

For most, if not all outside wooden structures in America, as well as in most European countries, the wooden members are treated with some preservative and creosote, having proved its worth, is the preservative almost exclusively used. An important part of the treatment is that the various wooden members should be framed before any preservative treatment is given. Where it was proposed to give any tar or asphalt wearing surface to any existing bridge, it would be very necessary to treat, so far as possible, the existing timbers and to ensure that the decking was sound and treated as thoroughly as could be. Once any wearing surface had been laid it would be very difficult to observe any decay of the timbers underneath and with decking of initial sound, treated planking, the wearing surface would give continued protection.

While wooden timber road-bridges are still largely used in America, an improved type of bridge decking has been brought out by the Oregon State Highway Commission, to whom I am indebted for the details as shewn in Fig. 2 (Plate 32) of the drawings. The road-bearers are arranged to give concentrated loading to the decking. The decking, in place of being layers of wooden planking, is made of reinforced concrete. I shew this construction as being of general interest. If any one reading this article wishes to get further details, he should correspond direct with the State Highway Engineer, Oregon State Highway Commission, as I have no personal experience to go upon and am not prepared to give technical advice in any particular case.

PROPAGATION AND USE OF KACHORA (CURCUMA ZEDOARIA ROSC. N.O. SCITAMINEAE)

By S. S. Dhareshwar

Habitat.—Kachora is a rhizome. It grows wild in waste lands and on abandoned village sites and in some parts of the moist deciduous forest in the coastal tract of Kanara (Province of Bombay). It is also cultivated in some coconut and arecanut gardens.

Uses.—The root has an aromatic smell. It has stimulative and carminative properties. It is useful in flatulence and dyspepsia. It is also used as an odorific ingredient in medicated oils. Locally it is chiefly used for its flour prepared from the tubers. The flour is a substitute for arrowroot and is highly valued as an article of diet, especially during convalescence following dysentery and similar stomachic troubles. It is a cooling, demulcent and nutritious food. It is a safe substitute for barley and is used in all cases where barley is indicated.

It is also made into confections by diluting the flour in water to the consistency of milk—say, in a proportion of an ounce of flour to a pint of water—sugar added to taste, a few crushed cardamom seeds or saffron and almond slices also being added. The dilution is then kept stirred on the fire and, in a few minutes, it gets thickened as a paste. The hot paste is taken out by a ladle and spread evenly to the required thickness on a china tray or plate to which an emollient, such as ghee or butter, has already been slightly applied. After the paste cools, it is cut up in cubes and is now ready for use. The confection lasts for a couple of days.

Mode of preparing flour.—The secondary roots yield but little starch. The flour yield is chiefly from the main tubers which are washed and peeled thoroughly and crushed and ground into a fine paste in a grinding stone. The paste is then diluted freely in water and left so for a day. The deposit settles down in the bottom and the water is then slowly removed from the vessel. The precipitation is again diluted in fresh water and strained through fine linen and allowed to settle down. The process is repeated several times until the bitter taste is lost and the colour turns quite white. About half a dozen strainings are thus required in about as many days. The final precipitate is dried in the sun and is then ready for use.

Economic aspects of working.—Inasmuch as the turnover is limited and the mode of preparation is laborious, the flour sells dear. It is, therefore, chiefly used by the higher classes in confectionery and porridge for children. In case the cultivation be extended under controlled extraction and a suitable method of propagation of the rhizome and the means of crushing be also improved,

the annual flour yield can be increased and the price brought down so that even the poor classes may afford to use the flour more liberally. The flour-making is now mainly a subsidiary industry for the womenfolk.

(*i*) Cost of working:

	Rs.	a.	p.
(*a*) Wages to collect one maund or 28 lb. of tubers—one day for a woman ...	0	3	0
(*b*) Peeling, crushing and grinding 28 lb. tubers—one day	0	3	0
(*c*) Straining done during three days—in all four hours or half-day's work ...	0	1	6
(*d*) Sundries	0	0	6
Total ...	0	8	0

(*ii*) Earnings:

(*a*) Flour yield from 28 lb. of tubers according as the tubers are mature=four to six lb. at three to four annas per lb. ... ... Rs. 0-12-0 to Rs. 1-8-0.

Propagation.—Kachora can be easily propagated by cuttings. The rhizome or secondary roots can be cut up and small pieces with the buds planted in slightly raked soil at the beginning of the monsoon. Even the thick peelings with eyes on sprout in favourable situations. Shady conditions in arecanut gardens and the banks of irrigation channels afford very congenial places for the cultivation of Kachora. The immature tubers are poor in starch content and it is the present uncontrolled and improvident way of extraction of the tubers by the womenfolk which has been responsible for the yield of flour that does not fetch an adequate return for the labour involved. A two-year rotation would provide sufficient time for the full development of the tubers whose starch yield would thereby be enhanced. The cultivation of Kachora, therefore, deserves to be taken up on a systematic basis and developed into a cottage industry to supplement the income of the owners of gardens or their tenants.

HONAVAR:

10th July 1939.

EVERGREENS IN CUDDAPAH

BY E. K. KRISHNAN

It is not generally known to residents in Cuddapah that there are patches of evergreen forests in the district. This ignorance is not, however, surprising, for few people would associate evergreens with Cuddapah Forests. A district, with scarcely 30 inches of rainfall, and where the temperature shoots up to 110 degrees in March and remains thereabouts for about three months in the year, is no place for evergreen forests.

2. But there are evergreens and evergreens. And the type met with in Cuddapah District is not to be confused with the evergreens of the rains forests, like in South Kanara, Malabar and Coimbatore. The Cuddapah evergreens come under the category of dry evergreens—a contradiction in terms, one would think, but a very apt description for the stunted and scattered patches of green forests met with in unmistakably dry regions of the country. What a contrast to the magnificent timber forests, teeming with life, which one sees in the wet district elsewhere in the Presidency!

3. It came as a surprise to me to reach one of these forests during my excursion in February last in this Division. I am familiar with dry evergreens in parts of Salem District and on the Mysore Plateau, but there they occur on plateaus ranging in elevation from 3,000 to 4,000 feet. The valley I am about to describe is barely 500 feet in elevation.

4. It is situated in the Velikonda Hills of North Cuddapah Forest Division in what is known as the Marlabailu Valley, near the Nellore-Cuddapah District boundary, in longitude 79°-26 and latitude 14°-20′. It is about 57 miles distant from Cuddapah. A stream locally called "Kalletivagu," drains the valley, which is about 12 miles long from south to north, and joins the Pennar about eight miles east of its confluence with Cheyyar River.

5. To reach this valley one has to cross the spur of hills from Kondur along a tortuous bridle-path, 11 miles long, constructed in 1920 by the Forest Department at a cost of about Rs. 4,000. I mention this bridle-path as, without the facility which it affords to traverse an uninteresting country, very few would be tempted to explore this barren, steep hill-side on any quest of adventure or game.

6. Bare hill-sides are, as is well-known, a common feature of Cuddapah scenery and one has only to inspect the unreserved areas at the foot of this spur to find out the cause of this denudation. Large herds of goats are kept by the villagers and these are let loose in the scrub jungle to feed on whatever they can get at. The grazier, armed with a long-handled hook, indiscriminately hacks away the tender, juicy shoots of taller trees to feed the goats on and thereby helps the process of destruction. In the hot months the scrub jungles are fired to obtain early grass for cattle. Whatever is left of the tree and shrubby growth is used to make charcoal which finds a ready sale in the adjoining villages. Is it any wonder that forest growth should disappear when maltreated in this way?

7. The Government Reserved Forest adjoining these unreserved areas is a shade better wooded than these. Though fire has taken its toll, the goat has not penetrated into it and hacking and charcoal burning are less evident. The ravages of annual fires have, however, left their mark. Vast extents of "botha" (*Cymbopogon coloratus*)—ridden scrub jungle, meet the eye for miles and miles all along this spur. As one penetrates deeper into the forests, hardy species like those enumerated below are met with:

Anogeissus latifolia, Red sanders, *Ochna squarrosa, Albizzia amara, Buchanania lanzan, Plectronia didyma, Strychnos nuxvomica, S. potatorum, Bassia latifolia, Ixora parviflora, Erythroxylon monogynum, Gardenia gummifera, Webera corymbosa, Feronia elephantum, Terminalia chebula, Lannea grandis, Cochlospermum Gossypium.*

8. The top of the spur is about 2,000 feet in elevation and here *Phoenix acaulis* and *Hibiscus lampas* predominate. The latter is a useful fibre-yielding plant which is leased out for fibre by the Department and this spur is one of the few localities in the Division where the shrub exists more or less in pure patches.

9. It is after crossing the spur that vegetation slowly changes into a moist type and what a relief it is to descend into a valley where the cool, deep shadow of evergreen forests invites rest and relief from the scorching sun. This is a treat doubly welcome, when it is realised that the temperature may be anywhere near 100

degrees even in February outside these patches of evergreen forests and you have just left a fire-swept western slope of weary, uninteresting scrub jungle to enter a type of vegetation so different from what has hitherto been met with.

10. The general aspect of the country beyond the spur top is eastern and the striking peculiarity of vegetation that one notices is the preponderance of evergreen species like *Plectronia didyma, Maba buxifolia, Memecylon edule, Hemicyclia sepiaria, Limonia alata, Atalantia monophylla, Linociera zeylanica, Ixora parviflora* and *Pterospermum suberifolium*. *Phyllanthus lawii* occurs along beds of streamlets. Amongst other tree growth may be mentioned some of the species commonly met with in deciduous forests, like *Vitex altissima, Lannea grandis, Strychnos nuxvomica, S. potatorum* and *Wrightia tinctoria*. Once inside the evergreen forest the vegetation remains typically evergreen and besides the species mentioned in Paragraph 7 the following shrubs and creepers deserve mention:

Shrubs.—Dodonaea viscosa, Randia dumetorum, Gmelina asiatica, Gelonium lanceolatum.

Creepers.—Hugonia mystax, Hippocratea obtusifolia, Grewia rhamnifolia, Strychnos colubrina, Jasminum rigidum, J. arborescens.

Grass is conspicuous by its absence. The ground cover is made up of *Glycosmis pentaphylla* and a *Strobilanthes*-like glandular hairy weed which is really *Stenosiphonium russellianum, Barleria cuspidata, Blepharis boerhaaviaefolia, Justicia micrantha* and other weeds. Lower down this valley *Shorea tumbaggaia* makes its appearance and with it the type of vegetation slowly reverts to the deciduous type.

11. The patches of evergreen forests vary in size from 10 chains by three chains to sometimes 10 acres in extent and are seldom larger. That they occur at so low an elevation as 500 feet is a striking peculiarity of their growth in Cuddapah District as the writer's experience in other districts, as in North Salem bordering the Mysore Plateau, has tended to the view that such evergreens exist really at some elevation, say from 3,000 to 4,000 feet, and generally in most localities along streams.

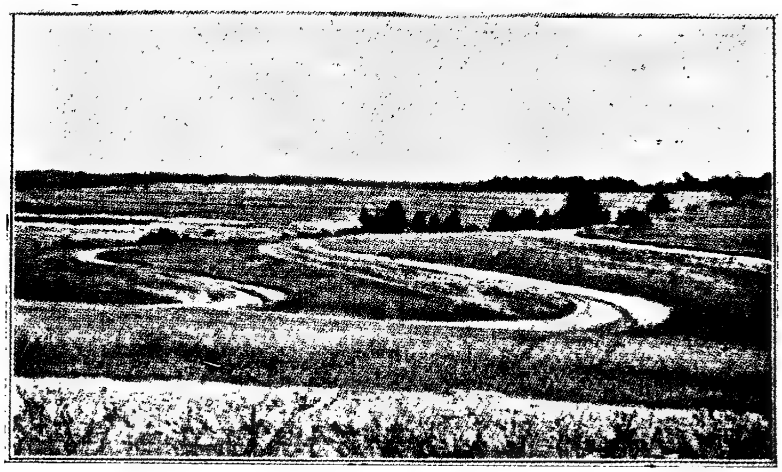
Fig. 1

Rice-lands form a natural catchment, yielding a slow and steady run-off.

Fig. 2

Unfortunately even rice-lands may be attacked by gullies eating up from deep-cut stream-beds.

Fig. 3



A terraced field.

One is left to conjecture whether larger patches of such forests did not exist in this District in former times (Cuddapah forests are reputed to have harboured elephants in 1860) and whether their disappearance is not attributable to the terrific effects of fire and hacking that these forests have been subjected to during centuries of occupation by "civilised" folk of recent times.

NOTE ON TERRACING FOR SOIL CONSERVATION AND LAND RECLAMATION

By G. W. D. Breedon

In the first instance it is necessary to explain the difference between terracing as done in the hills for agricultural purposes and terracing for soil conservation as performed by tractors and graders.

Hill terracing will be designated "Step-Terracing," which term correctly describes the flight-formation into which the hill-slope is stepped off, each stair having a flat top with a stone retaining wall below. In this method a retaining wall, usually of dry uncoursed rubble, is built on a contour line and the land some distance above it on the higher side of the slope is cut down and the earth used for filling in the lower side, so that a table-like surface is obtained. A badly step-terraced hillside, with defective drainage invariably results in a landslide.

Another crude type of terracing on gentle slopes for the growing of rice is the "Watt-Bandi" system. Two pictures taken from Maclagan Gorrie's "Soil and Water Conservation in the Punjab" and reproduced as Figs. (1) and (2) of Plate 33, serve to illustrate the method. Unless the gullies below the fields are properly plugged, the rice-fields above will be attacked by upward creeping erosion from the deep-cut stream below them.

I have read with much interest the very excellent pamphlet issued by the Commissioner, Rural Reconstruction, Punjab, on the "Watt-Bandi" System, but since this system is wholly applicable to agricultural lands on the flat or on very gentle slopes only and cannot be beneficially extended to lands beyond this very limited

classification, it cannot be accepted as a method of soil conservation. Those who think that it is a system complete in itself for general application to all lands attacked by erosion will soon find that they were seriously mistaken and that all their energies in the "Watt-Bandi" drive were wasted. Disappointment certainly awaited those engaged on the job in the Shakargarh Tahsil of the Gurdaspur District recently. "Watt-Bandi" also cannot be applied to extensive areas. "Watts" serve as a check on the flow of water as long as water does not overtop the "Watts," but there is hardly an area of any size, where conditions are ideal for the control of flow. Even on the gentlest of slopes there will always be found an excess of water over the amount that is evaporated and absorbed and that excess has to find an escape. The volume of water at the lower end of a slope is greater than the amount at the upper side due to the downward flow and as it moves downwards it gathers velocity and with it its erosive and carrying powers increase.

The only way to check the destructive action of water is to throw terraces across the path of the water. Such terraces divide the long slope into compartments and at the same time they alter the direction of flow. They also prevent excess water from the compartment above from entering upon the compartment below, so that each compartment in the terraced area carries only that amount of water which falls in the shape of rain upon it. Since supply is thus restricted, the control over any surplus on that particular area is greatly simplified. Each contour terrace is provided with a wide ditch on the upper side of the slope and a levee on the lower side. The ditch has a gentle fall towards a drainage gully. Thus a waterway is created, which provides for the slow removal of surplus water from the land to the drain. In this manner no large volume of water is allowed to flow over the slope and to carry away with it any amount of fertile top-soil. Gullying is also checked.

No form of terracing can be advanced as an absolutely perfect method for the stoppage of soil movement. Even on the most perfectly laid out terraced area, there is bound to occur a certain amount of soil displacement and shifting with every shower of rain; but it can be claimed that movement will be reduced to a minimum and that most of the soil that gets mixed up with the water will be

deposited on the field by having the velocity of the run-off water retarded along the terrace drain.

In the division of an area into terraced compartments, in the diversion of water by horizontal ditches and bunds into gullies on either side and in the restriction of the flow of water off the land lies the secret of success of the terracing system of soil conservation. Fig. 3, Plate 33, gives a very good idea of what a terraced field looks like.

But it must not be assumed that the protection of soil has been completely attained when an area has been terraced and gullies plugged. On arable land the farmer shall have to resort to contour ploughing and rotational cropping, not failing to go in for the growing of legumes and the use of manures. On poorer soils re-afforestation shall have to be carried out, but first of all "sarkanda," elephant grass and the like should be grown to afford soil cover.

In the light of efficiency, expedition and economy there is nothing to compete with machinery in terracing for soil conservation and the reclamation of land. Large power units are recommended for the construction of terraces, because they are the most economical in the long run. The speed with which channels are cut into the subsoil and bunds built simultaneously is most agreeably surprising. The result, too, is all that can be desired. The windrow is not composed entirely of valuable top-soil and it is not ridged and, unlike the mound type, there is no sharp drop on the downward side of the slope. On a well-terraced plot the terraces are hardly perceptible; they blend, so to speak, into the slope and offer no obstruction to contour cultivation. Tractors and graders, or bull-graders and bull-dozers for building banks across gullies, which graders and terracers cannot do, constitute the equipment necessary for the works.

There are many ways to protect the terrace outlets into gullies. The fall can be made V-shaped and paved with stones, bricks or timber and weirs can be constructed of stones or timber where the drop is several feet from the drain to the gully. Such works offer no engineering difficulties, but the officer in charge should see that the most suitable locally procured materials are employed in order to keep down costs and that all timber is treated with preservatives. Don't use saligram oil instead of solignum.

On the other hand, "Gully-Plugging" calls for the special attention of the engineer in charge. He should make a very careful inspection of each gully and select suitable sites for the making of bunds, hurdles falls, weirs and the like. Wherever an outlet exists, or can be created, from one gully to another, one of the gullies can be closed by throwing an earth bund across a narrow portion. The bull-dozer can do this both quickly and cheaply. In fact this machine can perform prodigious work in the hands of an experienced operator and keeps down costs. Economy is the most essential factor in terracing, especially in India, where the peasant is poor and the Government not rich. Almost every gully is capable of having some portion of it reclaimed for agriculture or planting and by the judicious placing of hurdles across its channel much soil-building can be done. At first short hurdles can be thrown across the deeper channels and when silting has taken place, another hurdle can be built some distance higher up and across a wider portion of the gully. In this manner not only will land be reclaimed (and the soil will be good since it will be top-soil carried down by the water and deposited when it meets with obstruction at the hurdle) but the bed of the gully will be materially improved by being gradually converted into a series of gentle slopes with moderate falls. The newly-formed land on either side of the stream can be planted or otherwise used. It should be used in order to make the reclamation permanent. The best form of hurdle that appeals to me for general use is the post and wire-net fence, strutted of course, with either a brushwood strainer, or a "sarkanda" or split-bamboo chick, on the up-stream side, which will impede the flow of water and cause its load of silt to be deposited. The process of land-building in gullies could be greatly facilitated and accelerated by machines being employed on the sloping of gully-banks and the breaking down of unwanted knolls or "tibbas" in the eroded channel. There are a thousand and one other jobs that the bull-grader and the bull-dozer can do and do well and cheaply on terracing. Those who have handled these machines know their value.

For whatever purpose terracing is required it must be done economically and at the same time properly in all respects. Efficiency cannot be sacrificed on any account. In America where terracing is being done on a very large scale, highly trained engineers and

skilled machine operators are invariably engaged. Wages there are high, yet the cost is comparatively small and well within the means of the smallest farmer. In most states extension work in agriculture and home economics is carried out on the co-operative system and the method of financing terrace projects is interesting. The county board of revenue, which is the appropriating board of the county underwrites the purchase price of the terracing plant and the Department of Agriculture Co-operation make a charge to the farmer, on whose farm the work is being done, of three dollars per hour for the terracer and four dollars per hour for the bull-dozer for the actual time spent on the job. These charges include a tractor operator and machine operator for the terracer and an operator for the bull-dozer. The charge also includes a surveyor and rodmen who are engaged on laying out the terrace lines just ahead of the machinery. The surveyor is usually the foreman of the party. Of course the hourly rates include fuel-oils, grease, lubricants and depreciation. Under normal conditions one dollar per hour goes towards the purchase price of the equipment and instruments. G. B. Phillips, County Agent, Alabama, in his letter of December the 10th, 1937, assured me that the complete job of terracing, including checking the terraces to see that no error has been made in slope and grade, works out to an average of two dollars per acre payable by the farmer. In India where labour is infinitely cheaper the cost should not exceed one rupee per acre under the most trying circumstances.

In a previous paragraph I mentioned the need for a careful inspection of gullies so as to determine the best methods of plugging. In this I desire to emphasise the importance of a complete reconnaissance of the entire land to be terraced. The topography of the country should be noted, as also the grades, the classes of soil, the natural drainage channels, the approximate lengths of terraces and the directions in which they should be drained. The positions of outlets should also be determined. The more complete the reconnaissance the simpler will it be to plan the layout and to supervise the operations. Great care shall have to be taken to prevent injury to roads and neighbouring properties by the discharge of drainage from the terraces.

Next in importance comes surveying. It is most important to know the slope of the land in order to determine the vertical fall between the trenches of the terraces. The distance between any two terraces is of vital importance for on it depends the area of land that will drain into the trench. The grade, or fall, in a trench is not a very simple matter for the inexperienced to decide nor can the grade be laid out without a surveyor using a level. To do the work in any other manner will be courting disaster. When the work can be done by skilled men at so low a rate, there is no need to try to effect further economies by employing untrained persons and resorting to less accurate means.

Two tables are given below which will serve as additional guides for determining the vertical falls between terraces and the grades of the terrace drains or ditches.

Table for Determining Vertical Falls Between Terraces in Relation to Land Slope

Slope per cent. in feet.	Vertical Fall from terrace to terrace	Horizontal Distance from trench to trench
1 foot	2 feet 6 inches	180 feet
2 feet	2 „ 9 „	140 „
3 „	3 „ 0 „	100 „
4 „	3 „ 3 „	80 „
5 „	3 „ 6 „	75 „
6 „	3 „ 9 „	63 „
7 „	4 „ 0 „	57 „
8 „	4 „ 3 „	53 „
9 „	4 „ 6 „	50 „
10 „	4 „ 9 „	48 „
11 „	5 „ 0 „	45 „
12 „	5 „ 3 „	43 „
15 „	6 „ 3 „	40 „

Drain Grades in Relation to Land Slope and Length of Terrace

Length of Terrace	Land Slope		
	5 per cent.	10 per cent.	15 per cent.
	On Clay Soil.		
0 to 100	0	0	0
100 to 400	1	1¼	1½
400 to 700	2	2½	2¾
700 to 1,000	3	3½	4½
1,000 to 1,300	4	4¾	5½
1,300 to 1,600	5	6	7
	On Sandy Soil		
0 to 100	0	0	0
100 to 400	¼	½	¾
400 to 700	¾	1¼	1½
700 to 1,000	1¼	1¾	2½
1,000 to 1,300	1½	2½	3¼
1,300 to 1,600	2	3	4

The engineer should, whenever possible, try to avoid sharp curves in trench lines and large fillings in deep and lengthy gullies. Large knolls can be terraced independently, but small ones need not be touched. Local depressions in the line of trenches can be cut through as long as the levee is raised to its right height and level with the rest of the embankment. Local depressions silt up quickly. The Engineer should remember that a gentler run-off is needed on a sandy soil than on a clay soil: also that the grade should be gradually increased with the length of the ditch in order to cope with the increased supply of water. When dealing with a long terrace, try drain-off in both directions, keeping the dividing section on a level, from 200 to 300 feet. The fall in short lengths of terraces can be made in one direction only.

When carrying a terrace across a gully, care should be taken to build a strong dam a little below the point of drain discharge to prevent scour and to raise the crest well above the level of the terrace. The safest rule is to allow three inches in the foot for settlement plus six inches for rain-wash. Slopes of dams should be three to one on both sides. Take care to make a strong job throughout, for the strength of a terrace is dependant on its weakest point. There should be no weakness anywhere.

In India, where holdings are small and cattle are used for ploughing, there will be no need for crossing the terraces while ploughing. As a matter of fact, the zamindar will himself find it best to resort to contour ploughing and to plough between terraces there is no objection to cultivating in the ditch and on the levee, provided always that the levee is not neglected, and the ditch filled in. Most men have the intelligence to know what is good and what is bad for them and they protect the good.

TIMBER PRICE LIST, JUNE-JULY, 1940

(ISSUED MONTHLY BY THE FOREST RESEARCH INSTITUTE).

Trade or Common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Baing ..	*Tetrameles nudiflora* ..	Assam ..	Logs ..	Rs. 35-0-0 per ton in Calcutta.
Benteak ..	*Lagerstrœmia lanceolata*	Bombay ..	Squares ..	Rs. 32-0-0 to 70-0-0 per ton.
,, ..	,, ..	Madras ..	Logs ..	Rs. 33-1-0 to 37-8-0 per ton.
Bijasal ..	*Pterocarpus marsupium*	Bombay ..	Logs ..	Rs. 69-0-0 to 90-0-0 per ton.
,, ..	,, ..	Madras ..	Logs ..	Rs. 41-2-0 per ton.
,, ..	,, ..	Bihar ..	Logs ..	Re. 0-14-0 to 1-7-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Re. 0-8-0 to 1-8-0 per c.ft.
Blue pine ..	*Pinus excelsa* ..	N. W. F. P.	12′×10″×5″ ..	Rs. 6-0-0 per piece.
,, ..	,, ..	Punjab ..	12′×10″×5″ ..	Rs. 6-8-0 per piece.
Chir ..	*Pinus longifolia* ..	N. W. F. P.	9′×10″×5″ ..	Rs. 2-8-0 per piece.
,, ..	,, ..	Punjab ..	9′×10″×5″ ..	Rs. 3-0-0 per piece.
,, ..	,, ..	U. P. ..	9′×10″×5″ ..	Rs. 3-2-0 to 3-8-0 per sleeper.
Civit ..	*Swintonia floribunda* ..	Bengal ..	Sawn material	
Deodar ..	*Cedrus deodara* ..	Jhelum ..	Logs	
,, ..	,, ..	Punjab ..	9′×10″×5″ ..	Rs. 4-8-0 per piece.
Dhupa ..	*Vateria indica* ..	Madras ..	Logs	
Fir ..	*Abies & Picea* spp. ..	Punjab ..	10′×10″×5″ ..	Rs. 2-10-0 per piece.
Gamari ..	*Gmelina arborea* ..	Orissa ..	Logs	
Gurjan ..	*Dipterocarpus* spp. ..	Andamans ..	Squares	
,, ..	,, ..	Assam ..	Squares ..	Rs. 68-12-0 per ton.
,, ..	,, ..	Bengal ..	Scantlings ..	Rs. 100-0-0 to 125-0-0 per ton.
Haldu ..	*Adina Cordifolia* ..	Assam ..	Squares ..	Rs. 62-8-0 per ton.
,, ..	,, ..	Bombay ..	Squares ..	Rs. 24-0-0 to 65-0-0 per ton.
,, ..	,, ..	C. P. ..	Squares ..	Re. 0-5-0 to 0-13-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 46-14-0 per ton.
,, ..	,, ..	Bihar ..	Logs ..	Re. 0-9-0 to 0-12-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Re. 0-6-0 to 0-10-0 per c.ft.
Hopea ..	*Hopea parviflora* ..	Madras ..	B. G. sleepers..	Rs. 6-0-0 each.
Indian rose-wood ..	*Dalbergia latifolia* ..	Bombay ..	Logs ..	Rs. 62-0-0 to 100-0-0 per ton.
,, ..	,, ..	C. P. ..	Logs ..	Re. 0-10-0 to 2-0-0 per c.ft.
,, ..	,, ..	Orissa ..	Logs ..	Re. 0-12-0 to 1-12-0 per c.ft.
,, ..	,, ..	Madras ..	Logs ..	Rs. 62-8-0 to 125-0-0 per ton.
Irul ..	*Xylia xylocarpa* ..	Madras ..	Logs ..	Rs. 56-4-0 per ton.
Kindal ..	*Terminalia paniculata* ..	Madras ..	Logs ..	Rs. 40-10-0 per ton.
Laurel ..	*Terminalia tomentosa* ..	Bombay ..	Logs ..	Rs. 40-0-0 to 65-0-0 per ton.
,, ..	,, ..	C. P. ..	Squares ..	Re. 0-12-0 per c.ft.

Trade or common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Laurel ..	*Terminalia tomentosa* ..	Bihar ..	Logs ..	Re. 0-9-0 to 0-12-0 per c.ft.
" ..	" ..	Orissa ..	Logs ..	Re. 0-6-0 to 0-12-0 per c.ft.
" ..	" ..	Madras ..	Logs ..	Rs. 32-9-0 to 37-0-0 per ton.
Mesua ..	*Mesua ferrea* ..	Madras ..	B. G. sleepers..	Rs. 6-0-0 each.
Mulberry ..	*Morus alba* ..	Punjab ..	Logs ..	
Padauk ..	*Pterocarpus dalbergioides*	Andamans ..	Squares ..	
Sal ..	*Shorea robusta* ..	Assam ..	Logs ..	Rs. 31-4-0 to 75-0-0 per ton.
" ..	" ..	" ..	B. G. sleepers	Rs. 5-14-0 each.
" ..	" ..	" ..	M. G. sleepers	Rs. 2-12-0 to 2-14-0 each.
" ..	" ..	Bengal ..	Logs ..	Rs. 50-0-0 to 87-8-0 per ton.
" ..	" ..	Bihar ..	Logs ..	Re. 0-12-0 to 1-4-0 per c.ft.
" ..	" ..	" ..	B. G. sleepers..	Rs. 5-0-0 to 5-4-0 per sleeper.
" ..	" ..	" ..	M. G. sleepers..	Rs. 2-0-0 to 2-8-0 per sleeper.
" ..	" ..	C. P. ..	Logs ..	Rs. 1-2-0 to 1-4-0 per c.ft.
" ..	" ..	Orissa ..	Logs ..	Re. 0-8-0 to 1-4-0 per c.ft.
" ..	" ..	U. P. ..	Logs ..	Rs. 1-2-0 to 1-6-0 per c.ft.
" ..	" ..	" ..	M. G. sleepers..	Rs. 2-4-0 to 2-8-0 per sleeper.
" ..	" ..	" ..	B. G. sleepers	Rs. 5-10-0 to 5-12-0 per sleeper.
Sandalwood ..	*Santalum album* ..	Madras ..	Billets ..	Rs. 306-0-0 to 639-0-0 per ton.
Sandan ..	*Ougeinia dalbergioides* ..	C. P. ..	Logs ..	Re. 0-8-0 to 1-0-0 per c.ft.
" ..	" ..	Bihar ..	Logs ..	Re. 1-0-0 per c.ft.
" ..	" ..	Orissa ..	Logs ..	Re. 0-12-0 per c.ft.
Semul ..	*Bombax malabaricum* ..	Assam ..	Logs ..	Rs. 38-0-0 per ton in Calcutta.
" ..	" ..	Bihar ..	Scantlings ..	Re. 0-10-0 per c.ft.
" ..	" ..	Madras ..	Logs ..	
Sissoo ..	*Dalbergia sissoo* ..	Punjab ..	Logs ..	
" ..	" ..	U. P. ..	Logs ..	Re. 0-12-0 to 1-8-9 per c.ft.
" ..	" ..	Bengal ..	Logs ..	Rs. 80-0-0 per ton.
Sundri ..	*Heritiera* spp. ..	Bengal ..	Scantlings ..	Rs. 175-0-0 per ton.
Teak ..	*Tectona grandis* ..	Calcutta ..	Logs 1st class..	
" ..	" ..	" ..	Logs 2nd class	
" ..	" ..	C. P. ..	Logs ..	Re. 0-13-7 to 2-0-9 per c.ft.
" ..	" ..	" ..	Squares ..	Re. 0-8-2 to 2-4-7 per c.ft.
" ..	" ..	Madras ..	Logs ..	Rs. 57-5-0 to 143-12-0 per ton.
" ..	" ..	Bombay ..	Logs ..	Rs. 66-0-0 to 180-0-0 per ton.
" ..	" ..	" ..	M. G. sleepers..	Rs. 4-0-0 each.
White dhup ..	*Canarium euphyllum* ..	Andamans ..	Logs ..	

EXTRACTS

BOTANICAL SURVEY OF INDIA

The annual report for the year 1938-39 records the efforts made throughout the year to secure specimens of medicinal plant products, plant materials used as vegetable insecticides, etc. Commercial timbers, samples of hand-made and machine-made paper of different qualities have also received attention: in this connection one is tempted to ask if an activity in this direction may not be considered as a duplication of the work carried out by the Forest Research Institute at Dehra Dun.

Systematic botanists have been assisted by the survey and the Herbarium at the Royal Botanic Gardens has been strengthened by the addition of some 2,000 plants. Special attention should be invited to the investigations on the poisonous plants of India conducted by Col. Chopra and his collaborators.—*Current Science,* Vol. 9, No. 4, April, 1940.

FORESTRY IN BRITAIN

THE AIM OF NATIONAL POLICY—A LONG-TERM CONSIDERATION

Once again the exigencies of war have thrown into prominence Great Britain's past dependence on timber from Overseas and has given new impetus to the home-grown trade. After the wholesale depredations on home woodlands during the last war, steps were taken to lay down a national forest policy, and in more recent times there has been great concentration of effort on the task of leading private woodland owners to a truer conception of the importance of better woodland management.

In view of present circumstances, the Presidential Address of Mr. W. L. Taylor at the last annual meeting of the Society of Foresters of Great Britain (now available in pamphlet form) possesses a special interest. Mr. Taylor, who as readers know, is a Forestry Commissioner, declared that to those who had forestry in Great Britain so much at heart, the forest history of our country

presents rather a sorry picture of waste and indifference. "The fact is," he declared, "that our social, political and economic systems for as long as 1,000 years have combined to oust the industry of forestry from its natural position in our rural economy; in plain truth, as a nation we have not been foresters at all." Mr. Taylor, however, hopes for better things. The major planks in the forestry programme of to-day, he said, are supply and the rehabilitation of our depleted rural areas. Bearing in mind the ephemeral nature of previous bursts of forestry activity in Great Britain, which usually followed the periodic scares concerning oak for the Navy, or were introduced by the action of persons of influence, we must hope that the present organised effort will live to demonstrate the full and true value of systematic forestry to the nation. There is much missionary work to be done, however. In this country systematic forestry is a new thing and as such is often suspect. The innovation brought about by the Forestry Act, 1919, is as yet not very widely understood.

Science, Art or Business?—It is justifiable to enquire what forestry actually is, continued Mr. Taylor. Is it a science, an art, or a business? Surely forestry, in each of its main branches, silviculture, management and utilisation, is first and last an industry. In the raising and tending of forests each skilled task is itself an art, while in the successful practice of forestry empiricism is making way for the surer bases of scientific discovery in the many fields into which the foresters' problems extend. Science and art are, therefore, ancillary to the industry of forestry, which can be defined as the raising, tending, protecting and utilising of timber crops with the object of maintaining the maximum sustained yield from any given area of forest.

In countries possessing forests, or wishing to possess them, forestry activities must be regulated by national forest policy. Forest policy can be framed only after the consideration of many factors, not all of which lie within the province of the forester. Broadly speaking, forest policy, like any other, should be drawn up to serve the full range of a nation's interests. Great Britain's excursion into national forest policy is yet very young, and, it may again be said, so narrowly understood that it may be of advantage to examine the

benefits likely to accrue in this country. As we know, the goal aimed at in 1919 was the afforestation of 1,770,000 acres of bare land within a period of 80 years and the reconditioning of as much as possible of the 3,000,000 acres of woodland in private ownership.

Taking the short view, the immediate task has been, and is, to ensure as speedily as possible an adequate supply of pit timber in case of need, the replacement of the 450,000 acres or so of woods felled between 1914 and 1918, and, incidentally, to provide permanent employment and facilities for land settlement. In the larger aspect, the intention is to build up the nation's forest resources to the extent envisaged by the full 80-year programme. The real point is that a nation's forest policy, if it is to succeed, can never be a short-term consideration, and no policy can hope to endure over a long term of years if it is not manifestly of real value.

What, therefore, has a forest policy to offer to the people of Britain? In the first place our present reserves of readily exploitable standing timber are admittedly not extensive. Furthermore, in consequence of lack of method, a proper age-class distribution scarcely exists, and, lastly, our area of woodlands, that is our existing timber producing area, is quite inadequate from every important point of view. Hitherto we have been able to buy all the wood we have needed abroad, and it is just that facility with which timber has been imported into this country that has been so potent an inducement to forest neglect. As a nation we have been importers of timber at least from the 11th century. The question is one of supply, and although we cannot hope to become self-supporting as a result of present policy we can build up and maintain stocks of merchantable timber in our forests and woods on the principle of sustained yield that will enable us to meet any emergency, and in time to effect a substantial reduction in the large bill now paid every year to exporting countries.

Secondly, the annual outturn of a known volume of timber will enable the saw-milling and wood-working industries to expand and organise, because the primary essential in the development of manufacture is a sure and regular supply of raw material.

Then there is the lasting good a new industry can do in the direction of employment. Every newly created job of work requires

its man to do it, and although at first the amount of employment may not be spectacular, the numbers permanently engaged grow as timber production advances. The labour required to tend and protect an established forest, and to fell, extract and utilise the timber, very greatly exceeds the five men per 1,000 acres which, on the average, suffices in the early stages of afforestation.

Again—and this is certainly one of the not inconsiderable benefits—forestry offers a safe and certain means of permanent land settlement in and about the forest. Past experience has gone far to indicate that rural repopulation in Britain, which is one of the urgent and most difficult problems of modern times, can only be successful if accompanied by a guarantee of work for wages such as forestry can offer.

Fifthly, the creation of forests is also the creation of wealth, and there is much land throughout this island that will, within the range of practical economics, produce more wealth per acre per annum under a forest crop than any other, provided sound systematic forestry is practised.

The Psychological Aspect.—Lastly, there is the psychological value of forests as a national possession, a value that many people in this country are inclined to belittle and even deny. This attitude arises mainly from lack of foresight and inability to look beyond the young growing plantations of to-day. In regard to amenity, there is no species of forest tree, broad-leaved or conifer, with which imposing landscape effects can be obtained in the early stages of growth in plantation, but, as the nation's forest resources have so dwindled, forests, if we are to have them at all, must be built up again. To effect this purpose there has to be a beginning. It is fair to ask the acutely æsthetic-minded not to take the short view, but to look ahead to the mature forests of future years, to forest industry and the busy and increasing community of forest workers who have already begun to find home and livelihood within afforested areas, and also to the welfare of the generality of the people of Britain who will find healthy recreation in and about the forests and in the National Forest Parks on which a start has been made, as the peoples of other nations are finding it in theirs.

There can be no national forest industry without a policy, and national forest policy to be of service must be well conceived, well balanced and steadfastly persevered with. We may briefly consider the land as the basis of primary production in general, including timber production. Science and experience enable us to take liberties with mother earth, liberties to be regarded as privileges rather than the liberties they are because, if there is over stepping, the trespass will never fail to bring its penalty. Sympathy and understanding, that is, "land sense," is an essential part of the successful forester's make-up, and the secret of proper land utilisation. It is a narrowly conceived error to imagine it possible to go gaily on afforesting and to regard problems of land utilisation and management as incidental. They are not merely incidental considerations, but are fundamental, and they beset forestry in greater or less degree wherever it is practised. A working knowledge of problems of land management is required of foresters of to-day, and even in the vast areas of forest in America the administrative demands upon the forest services in this regard are continually growing.

Qualities of the Good Forester.—Finally, I would say a word about forestry as a profession. I have defined forestry as an industry, but for those in control of forest policy and administration it is also a profession, as in the case of those in the higher control of engineering, mining and other projects in the great industries concerned. A professional man may be said to be one who has equipped himself with specialised knowledge and is able to offer it for the service of others. It is idle to ask what kind of man will make a good forester, but he must at least be a man of character and intelligence and be possessed of good health. In point of fact he must be more than this, for forestry does not offer a comfortable round hole to the square peg. Important characteristics are understanding, resourcefulness, assiduity, business-like habits, ability to express oneself clearly, leadership, optimism, sense of humour, courtesy and tact and, last but not least, a strong sense of public service and the ability *and the will* to co-operate. Interest in true sport, outdoor life and things that grow are helpful attributes Without the right types of men forestry cannot hope to take and maintain its proper place in the economics of our country and as a branch of British husbandry.

The rewards of a professional forestry career may not appear startling in comparison with some of those yielded by the older professions or the business world, but they probably compare reasonably well with the average of either. As a profession, forestry, in the modern sense, is in its youth, and future prospects are likely to be in proportion to the value of public service rendered by those engaged in its practice, as prospects are in any other profession. It may seem trite to remark that there are other considerations, but without being self-righteous we may, nevertheless, say that there are. There is the fact of association with a great creative work, the satisfaction arising from the practice of just those qualities the work demands, the joys of dipping into the secrets of Nature and making things grow, the benefits of a life that is largely out-of-doors, and the means of developing a greater breadth of interest than is readily attainable in the everyday routine of so many other callings. Each different occupation imposes its own particular discipline on those who follow it, but on none need the shackles sit more lightly than upon those whose life work lies in the creation and maintenance of forests.—*Timber Trades Journal,* Vol. CLII, No. 3313, dated 24-2-1940.

A STUDY OF SOME PASTURE GRASSES AT THE ALLAHABAD AGRICULTURAL INSTITUTE

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Introduction.—The success of the dairy industry in this country depends a great deal on the availability of good pasture grasses as pastures throughout the world supply the cheapest and most economical food for live-stock during the growing season and also permit the utilisation of land too poor or rough to be used for other farm crops. The amount of food available for the animals in this country is not enough and many of them are not properly fed. So long as this goes on, the efforts being made now to improve the quality of live-stock by distribution of pedigree bulls will not be of much profit. Hence it is more or less imperative that we should increase the production of animal feed in this country.

The farmers of this country have made practically no effort to increase the production capacity of their pastures. They just depend on the prevailing conditions of the soil and the climate. No attempt was made to study seriously the production capacity or the carrying power of a pasture.

Knowing this state of things the Agronomy Section of the Institute was asked by the Principal to make a study of some of the indigenous pasture grasses of the farm. Accordingly an experiment was designed to test out three of the most common pasture grasses on this farm. These are: (1) *doob* (Cynodon dactylon), (2) *banderia* or *anjan* (Penniseum cenchroides) and (3) *janai* (Andropogon pertusus).

Laying Out the Experiment.—Due to the limitation of staff and some other facilities it was not possible to study certain agronomic characters of these grasses, such as: (1) their palatability and digestibility, (2) the effect of maturity on their composition, (3) the effect of frequent cutting or grazing on the total yield of these grasses, (4) the effect of manuring, etc. The experiment, however, was designed to test only two factors which we at the time considered important in connection with pasture grasses and the pasture problem in this country. These are: (1) yield per acre of each of these grasses, (2) the effect of cultivation on the yield of the grasses. So the experiment is a two-factor one, and was designed according to the present-day statistical methods of field experiments.

The type of lay-out was a randomised block lay-out. The dimensions of plots and total area were as follows:

The size of each plot was 12 × 60 feet. The size of a block was 72 × 60 feet. There were altogether six replications. The total size of the area of the experiment was therefore 72 × 60 feet × 6, or 25,920 square feet. The rows were 18 inches apart. So there were eight rows in each plot. The six blocks were arranged in two rows, so that the dimensions of the lay-out in the field was 216 × 120 feet.

The above grasses were planted in the monsoon season of 1937. Rooted slips were used in all cases for planting and were planted at a distance of about nine inches apart on the side of a furrow. The number of rooted slips used per row was therefore 80, or 960 per plot.

The grasses were irrigated occasionally as needed and three of the plots in each block were given frequent cultivation with a Planet Junior cultivator while the other three plots were not. No other treatment was given, except occasional removal of the weeds that might smother the grasses. The grasses were harvested with sickle when they were in full bloom. Each plot was harvested separately and its produce was weighed and recorded. Thus in the course of one year many of the plots yielded six cuttings altogether.

Results and Discussion.—It seems unnecessary to give the detailed data here; therefore, the total yield of six cuttings of each plot is given in the following table:

TABLE I.—TOTAL YIELD OF SIX CUTTINGS, IN MAUNDS (82 LBS.)

Treatment		Blocks						Total	
	Grasses	I	II	III	IV	V	VI	of each grass	of each treatment
Cultivated.	*Doob* ..	10·5	9·0	10·0	9·8	11·0	9·6	59·9	
	Banderia ..	9·6	18·4	16·3	12·8	11·0	13·9	82·0	
	Janai ..	16·2	11·7	16·1	13·9	13·1	14·2	85·2	227·1
Uncultivated.	*Doob* ..	10·2	9·9	13·2	11·0	12·1	11·7	68·1	
	Banderia ..	15·5	15·1	15·5	11·5	13·3	15·4	86·3	
	Janai ..	11·3	11·8	14·9	17·2	15·2	17·6	88·0	242·4
	Total ..	73·3	75·9	86·0	76·2	75·7	82·4	469·5	

The above data are the weights of green grass. So it was thought that since the important part of the fodder is the dry matter contained in it, a very crude method of estimating it was adopted. This consisted in weighing portions of green grass from each plot and then drying them in the sun. After a couple of days, these dried grasses were weighed again. The percentage of moisture lost in each case was determined. The data obtained showed that there was practically no difference in the percentage of dry matter in each of the three grasses. We, therefore, concluded that the statistical analysis of the weights of green grasses would give us valid conclusions.

The result of the analysis is as shown below:

TABLE II.—ANALYSIS OF VARIANCE OF THE ABOVE DATA.

Due to	Degrees of freedom	Sum of squares	Mean square	Z	Level of significance
Blocks ..	5	18·968	3·793	·0317	No significance.
Grasses ..	2	103·090	51·545	1·2730	1% significance.
Treatment ..	1	6·666	6·666	·2504	No significance
Error ..	27	109·096	4·040		

We, therefore, arrive at the following conclusions:

Uncultivated grasses	Cultivated	Significant difference
242.4	227.1	23.7

Janai	*Banderia*	*Doob*	Significant difference
173.2	168.3	121.8	20

It was, therefore, found that there was no statistical or significant difference in the yield of the cultivated and the uncultivated grasses.

Amongst the three grasses, *janai* and *banderia* have given almost the same yield. *Doob,* however, is very much inferior in yield to any of the other two. The fact that *janai* and *banderia* are more liked by cattle and also coupled with the fact that these give greater yields than other common monsoon pasture grasses such as *doob,* makes these grasses much more valuable as pasture grasses than other similar indigenous grasses in this area. However, *doob* is much more liked by horses, and is also a very useful lawn grass all over this country, and for that reason has a place in the agriculture of the country.

In order that one may get a better idea of the produce obtained per acre in the course of one year from these grasses, the yield data were converted to maunds per acre which are as given below. The grasses were planted in August, 1939, and the sixth cutting

was completed by the end of August, 1938:

Name of Grass		Without Cultivation Yield in Mds. per acre	With Cultivation Yield in Mds. per acre
Janai	...	887	852
Banderia	...	863	826
Doob	...	681	605

These yields seem somewhat high. But this is to be expected as the grasses were irrigated with sullage water. The grasses, however, yielded profusely during the rainy season even without any irrigation, but less so during other seasons of the year.

This same experiment was continued in the second year but without irrigation. We were able in the course of the year to get only two cuttings (compare this with six cuttings under irrigation). The yield data of the experiment are as given below:

TABLE III.—SHOWING THE YIELD IN MAUNDS OF THE THREE PASTURE GRASSES IN TWO CUTTINGS, WITHOUT IRRIGATION.

Treatment		Blocks						Total
Grasses		I	II	III	IV	V	VI	
Cultivated	*Doob* ..	2·0	3·3	3·4	2·8	3·7	4·1	19·3
	Banderia ..	3·5	3·2	6·6	3·9	4·0	3·9	25·1
	Janai ..	6·7	4·8	5·2	5·5	6·3	7·1	35·6
Uncultivated	*Doob* ..	2·4	3·1	4·2	2·0	2·3	5·3	19·3
	Banderia ..	3·6	5·3	6·0	2·8	3·4	3·8	24·9
	Janai ..	4·6	4·3	5·5	4·6	8·0	5·8	32·8

The result of the analysis of the above data is as shown below:

TABLE IV.—ANALYSIS OF THE ABOVE DATA:

Due to	D. F.	S. S.	Mean square	Z	Level of significance
Block ..	5	11·06	2·21	·3627	No significance.
Grasses ..	2	37·68	18·84	1·4342	1 % significance.
Treatments ..	1	·25	·25	·4709	No significance.
Error ..	27	28·88	1·07	..	

Thus the conclusion arrived at is as follows:

	Janai	*Banderia*	*Doob*	*Sig. difference*
Yield per grass ...	60.4	50.0	38.6	10
Yield of grasses in maunds per acre ...	302.0	250.0	193.0	50

	Cultivated grasses	*Uncultivated grasses*	*Sig. difference*
Yield per treatment ...	80.0	77.0	13.0
Yield per acre ...	266.7	256.7	43.3

Conclusion.—This experiment showed that the grasses which were cultivated did not show any superiority over those that were not cultivated. Therefore, the only care that these grasses need is the occasional removal of weeds and other grasses that do not have any fodder value, and which also may smother the pasture grasses. The experiment also showed that *janai* and *banderia* are superior to *doob* in respect of yield whether they are grown with irrigation or without it, and that *janai* is somewhat better in yield to *banderia* when grown without irrigation. However, *janai* does not seem to be superior to *banderia* when these two are grown with irrigation.—*The Allahabad Farmer,* Vol. XIV, No. 3, dated May, 1940.

TROPICAL HARDWOODS

PRODUCTION FOR THE CRITICAL OVERSEAS MARKET

By H. E. Desch, F.S.I., B.SC., M.A. (Oxon.)

The value of the local market is often lost sight of by those in the tropical hardwood field in the excitement and eagerness to obtain a footing in the rich overseas trade. Moreover, there is propaganda value to a Forest Department in developing such a trade, however small, and irrespective of its cost on a cubic-foot basis. The local department often has to ride storms of ill-informed criticism, arising from the failure of lay critics to appreciate the value of the unseen income from forestry enterprise. Such critics are impressed if an entry is secured in a new market. In the circumstances it is understandable that the export of new timbers from the tropics has received considerable publicity, but it is as well to remember that the total extent of this trade is limited.

To sum up, it may be said without fear of contradiction from informed critics that the value of the forest wealth in the tropical colonies is greatest to those colonies by way of local consumption. There is not, and never will be, any prospect of an expansion in the trade in tropical timbers comparable with that which has occurred over the last few years in Canadian softwoods. Individual tropical timbers cannot be produced to sell at £20 per standard, even in their countries of origin, and with freight charges in excess of 1s. per cubic foot, they must be regarded for export purposes as semi-luxury woods. Further, only those timbers which occur in profusion throughout a territory are worth considering from the viewpoint of their potential export value. By stimulating the local demand, however, cost of production can be reduced and the output of "cream" increased. From this angle lies the hope of increased production of timber suitable for the critical overseas market.

It may, perhaps, be added that there are no new timbers awaiting exploitation. The local inhabitants have discovered the best and put them to their most appropriate uses. Any others of exceptional merits occur in insufficient quantities to be worthy of consideration. On the other hand, more intensive working may result in one or two less abundant species being produced in sufficient quantities to justify their export, and changing local conditions may release supplies of others which at present are being absorbed locally.

Malayan Experience.—At this stage it is appropriate to quote figures to prove these assertions, and Malayan ones, being accessible to the writer, are as suitable as any others:

MALAYAN EXPORTS TO THE UNITED KINGDOM, 1932—1939.

Species	(FIGURES IN CUBIC TONS)							January—April, 1939
	1932	1933	1934	1935	1936	1937	1938	
Meranti ..	507	5,195	7,804	10,122	7,490	6,845	12,489	2,142
Keruing ..	202	4,896	5,571	6,141	15.819	17,085	12,397	13,121
Kapur ..	139	4,777	4,688	1,632	1,334	374	2,224	..
Jelutong ..	..	..	59	1,388	274	1,303	363	228
Mersarea ..	..	..	82	424	28	42	..	..
Geronggang	..	23	46	..	230	124	..	..
Kampas ..	..	..	..	..	5	..	..	..
Sepetir ..	..	278	159	..	..	..	..	..
Bintangor ..	..	..	35	..	..	..	..	..
Balau (Resak)	..	..	28	..	..	..	..	..
Total ..	848	15,169	18,472	19,707	25,230	25,773	27,473	

It will be seen from this table that from negligible beginnings a small but steadily increasing trade has been built up. Ten timbers have been offered to the market, but two account for 35 and 51 per cent. respectively of the total exports, and six together only one per cent.

Kapur and Jelutong, the other two timbers, call for special mention since promising beginnings appear to have petered out. Kapur is popular in the Peninsula and commands a ready sale in normal times. Unfortunately, it is liable to attack from "pin-worm" damage, past attack in the living tree of pests belonging to the Ambrosia group of beetles. The local market takes no notice of this "defect," but its presence results in degrading a high percentage of the outturn when graded in accordance with the Empire rules for hardwoods. In the circumstances, the prices offered for the available supplies of prime quality are insufficient to attract the local producer, except in slump times. Jelutong is very liable to blue stain, a "defect" which is neither here nor there in a pattern wood, the purpose for which the timber is eminently suited. It is possible that the receipt of a shipment with rather more blue stain than usual may have been used as a lever to depress prices, and the consequences are amply reflected in the 1936 export figures. That the revival in 1937 was not maintained may be attributed to the new outlets tried failing to secure a sufficient price to attract the local producer. Figures for meranti and keruing, on the other hand, indicate that a real demand exists for these woods, and the fluctuations experienced can be accounted for by strong competition, supply and demand, and the disturbing influence of changes in freight rates.

The Malayan export trade has as yet hardly passed the initial stage of overcoming prejudice against new sources of supply, and the paralytic confusion in "trade" names is not helpful. The possibilities of expansion in this trade are apparent from the 1939 figures: in four months the exports of keruing have exceeded those for the previous 12 months. But it is because there is a local demand for inferior quality timber that the ability to deal with an expanding export trade exists: small saw-mills of the semi-portable type have sprung up at a phenomenal rate since the 1932 slump.

Others might take notice of Malayan experience, which is that only abundant species are suitable for export, and encouragement of the local demand is the best way of securing a margin of suitable quality for export.—*The Timber Trades Journal, Vol. CLI, No.* 3305, *dated December* 30, 1939.

INDIAN FORESTER

SEPTEMBER, 1940

SAL REGENERATION *DE NOVO*

By E. W. Raynor

I was interested to read the article under the above title, by Mr. W. D. M. Warren, in the June 1940 issue of the *Indian Forester.*

It is certainly a matter for satisfaction that the United Provinces have at last reached a probable solution of the problem of sal natural regeneration *de novo* for *Bhabar* sal (Champion's Type B3 or Moist High Level Alluvium sal), and the technique already developed on a practical (divisional) scale is fully described and explained in the articles on this subject by Mr. E. A. Smythies in the October 1939 and April 1940 issues of the *Indian Forester.*

It must be emphasised, however, that the solution applies to *Bhabar* sal and not necessarily to other types of sal in the U. P., nor to B2 (Moist Peninsular sal) which I understand is the predominant type in Singhbhum.

In his valuable work on "Regeneration and Management of Sal (*Shorea robusta*)," (published in Indian Forester Records, Vol. XIX—Part III, 1933), Mr. H. G. Champion makes it clear that Type B2 (Moist Peninsular sal) has much in common with the Moist Western (Himalayan) hill sal (Type B1) of the U. P., notably in the relative ease of regeneration and the absence of serious weed competition or heavy grass. Natural regeneration is certainly not a problem in the B1 hill sal of the U. P., and given reasonable protection from fire and excessive grazing (especially on more exposed or drier slopes), natural regeneration has not appreciably failed so far to keep pace with the fellings.

As the sal in Singhbhum is similar to the U. P. hill sal, it does not seem surprising that burning has been given up there as detrimental.

In U. P. *Bhabar* sal we practise annual burning in the early phase of the sal regeneration sequence (*de novo*) with the primary

object of reversing the evergreen progression which has undoubtedly resulted from half a century of more or less complete protection from fire, often aggravated by lack of or inadequate thinnings. We do not claim, however, that annual burning (under a moderate to fairly heavy canopy) is the only or best method of replacing a heavy undergrowth consisting predominantly of evergreen weeds by a lighter and more open undergrowth consisting of mixed *Imperata* grass and *Clerodendron,* knee high, which we know by experience to be indicative of soil conditions favourable to *Bhabar* sal regeneration *de novo.* It is the cheapest method, however, as compared with intensive shrub cutting, which, especially when applied during the rains, produces the same result. It is interesting to note at this point that in some of the U. P. transitional types from B3 to damper low level alluvial (B4) sal, we are finding it necessary to reinforce annual burning by intensive rains shrub-cutting in order to reduce the evergreen undergrowth and to bring in *Imperata* grass, as burning alone has been found insufficient. I do not suggest that burning the leaf-layer is a decisive factor in sal regeneration, but burning of excessive accumulations of sal leaves is undoubtedly favourable to regeneration in U. P. *Bhabar* sal. An accumulated mass of dead sal leaves becomes definitely inimical to sal regeneration.

On the subject of burning sal recruitment of only one season's growth, U. P. Forest Bulletin No. 2 of 1929, on "Resistance of Seedlings of sal (*Shorea robusta*) to burning," by M. D. Chaturvedi, shows that far from all seedlings of the year being killed, the survivals in forest conditions were 46 per cent., and that part of the mortality of 54 per cent. must necessarily be ascribed to factors other than burning. Mr. Chaturvedi also established that the immunity to fire of two-season-old seedlings is greater than that of one-season-old seedlings. I am now inclined to the view that fire-protection of sal recruitment of only one season's growth will rarely be necessary in B3 sal except in very dry localities. A recent individual seedling study, in the burning of sal seedling recruitment only one season old, revealed a survival of 70 per cent. in the December of the year of burning. Even if the percentage of survivals is as low as 25 per cent., this appears sufficient to build up

the necessary concentration of regeneration, while at the same time the evergreen weed growth remains under control due to the burning. A comparison of the 1939-40 observation in Indicator Lines with those of about six years ago in certain *Bhabar* sal experiments has disclosed that in spite of annual burning the concentration of seedling regeneration per six-foot square has increased on the average by approximately 50 per cent. It is admitted that the percentage increase in concentration was greater in certain unburnt controls, but it must be borne in mind that even the unburnt controls had a history of occasional accidental burning prior to the inception of the experiments, and also that during the currency of the experiments, shrubs and grass have been cut annually in winter, thus favouring regeneration.

The sal regeneration problems of the U. P. cannot be said to be due entirely to climatic causes. The problem which engaged so much attention in B3 sal during the past two decades was obviously due to the unnecessarily complete fire-protection applied since about 1880, and also to lack of or inadequate thinnings, resulting in a progression from the sub-climax type conditioned by periodic burning (before the Forest Settlement of 1880) towards the true climatic climax (*i.e.*, closed high forest of sal with evergreen admixture, evergreen underwood and evergreen undergrowth), in which conditions are quite unfavourable to sal regeneration. Now that silvicultural and hygienic thinnings are regularly applied to sal and since a burning régime in the early phase of the regeneration sequence has now become the accepted practice, the problem should disappear.

There is no case for contour trenching in our *Bhabar* sal forests, which cannot be compared with the Singhbhum forests, being a distinctly different type as regards climate, terrain and growth. The U. P. *Bhabar* tract, moreover, consists of very gently sloping or almost flat *thaplas, duns* or terraces at the foot of the hills and would not be suitable for contour trenching, even if it were established that this treatment could improve the rainfall. As far as I am aware, the forests in the *Bhabar* tract in Nepal are not appreciably higher in altitude than the corresponding forests in the U. P. *Bhabar* tract. They lie to the eastward of the U. P. *Bhabar*

sal tract in which most of the investigations on the sal regeneration problem have been carried out and not above or to the northward, as Mr. Warren appears to think. The rainfall is much more in Nepal, of course, presumably due to the preponderance of the Bay current of the monsoon. I regret that I have at hand no rainfall data for the Nepal sal forests, but I think I can safely say that it is accepted that the rainfall incidence increases from west to east and that a régime of fire protection and complete protection from grazing would in Nepal undoubtedly result in a strong evergreen progression *en masse* in the damper conditions there, which would lead towards a climatic climax of sal with a strong evergreen admixture and evergreen undergrowth, just as in the Lower *Bhabar* sal forests of Bengal and the Kamrup forests of Assam. The reason that sal regeneration in Nepal presents less difficulty is that the repeated burnings and a fair amount of grazing have actually kept in check the potential evergreen progression, thus assuring soil and ground cover conditions favourable to sal regeneration, which comes in and develops readily to the "whippy" or "large-leaf" stage in this environment. . . . .

I think it is probable that a slightly higher incidence of rainfall at the opening of the monsoon season would be beneficial in U.P. *Bhabar* sal, but I do not see how we can achieve this. The terrain in the U. P. *Bhabar* tract and in all other U. P. sal areas where regeneration is difficult would not permit of contour trenching and it does not seem possible in any case that this measure could hasten the arrival of the monsoon.

CANOPY CONDITIONS

It has been proved in practice time and again in U. P. *Bhabar* conditions that drastic opening of the upper canopy before an adequate concentration of whippy sal regeneration has been obtained, combined with fire-protection, results in a massive development of evergreen weeds. Similar premature drastic opening of the canopy combined with repeated and intense fires, results in excessive development of thatch (*Imperata*) grass. In either case these conditions are quite unfavourable to sal regeneration *de novo*, no doubt due to excessive root competition from weeds and grass respectively. We now carry through the burning phase under a moderate to

fairly heavy canopy with the "pepper-pot" openings described, until such time as an adequate flush of whippy sal regeneration is obtained, growing amidst a light ground cover of thatch and *Clerodendron,* knee-high.

Having reached that point we open the canopy drastically in one or two operations as necessary and at the same time fire-protect, with deer-proof fencing and rains shrub-cutting as necessary, in order to favour the regeneration on the ground. We do not aim to increase the concentration of regeneration on the ground by drastically opening the canopy, but to increase the vigour of the existing regeneration in the additional light admitted. Where there is no frost hazard we practically clear-fell, just as is done apparently in Singhbhum, where I presume that an adequate flush of whippy regeneration is already present on the ground at this stage. Where the frost hazard exists, we leave a light shelterwood as a protection.

Experience in the U. P. certainly shows that if whippy sal regeneration is left too long under a moderate to heavy canopy it invariably falls off in size and development and eventually disappears and there is no doubt that this is due both to lack of light and excessive root competition.

BORI RESERVE, 1859—1940

BY T. MCDONALD, I.F.S.

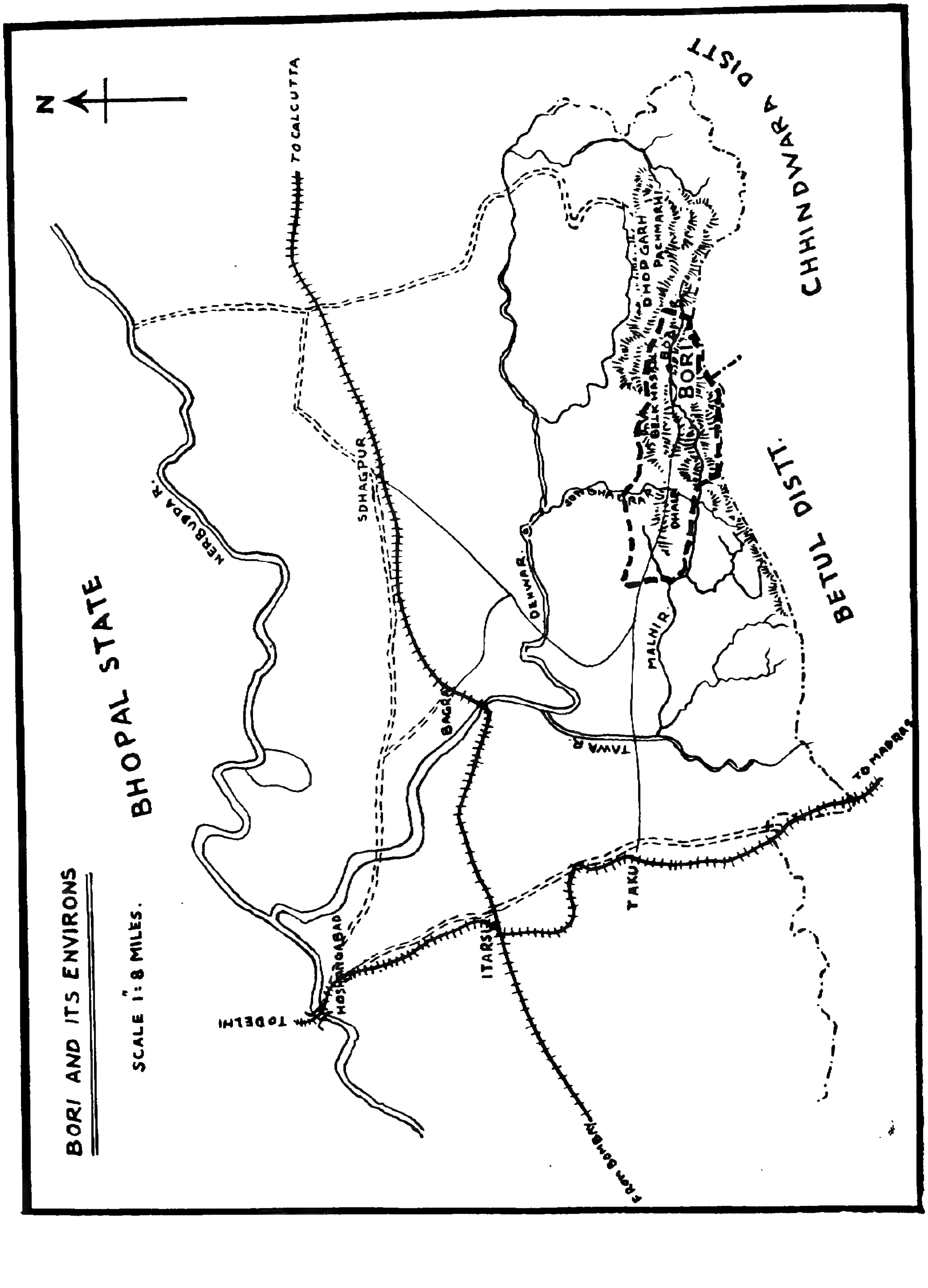
The Bori Reserve of Hoshangabad District in the Central Provinces has a very early claim to fame as being the first forest in India to be reserved. At the time of the Indian Mutiny it belonged to the Korku Jagirdar of Pachmarhi, Thakur Bhabut Singh, from whom it was confiscated in 1859 after the suppression of a rebellion which he led. It seems probable that the first official visit to these forests was made by Captain Forsyth, the author of that most informative and interesting book, "The Highlands of Central India," who was sent by the Chief Commissioner of that time to make an exploratory tour of the Satpura Range and who first realised the possibilities of Pachmarhi as a sanatorium. He stayed on the Pachmarhi plateau sufficiently long to build the first bungalow there, "Bison Lodge," and must have made expeditions into

the Bori Forests during 1862, the year in which it became a reserved forest. While Forsyth was in Pachmarhi the Conservator of the Nerbudda Territories, Colonel A. C. Pearson, whose headquarters were at Saugor, visited Bori in 1864 at the request of Sir Dietrich Brandis, who had asked him to consider fire protection.

The Bori forests lie in the valley of the Bori River, which flows west from Dhupgarh (4,454 feet), the highest point in the Central Provinces, for a distance of about 12 miles to join the Sonbhadra River, which formed the western boundary of the original Reserve. The valley is more or less wedge-shaped, the point of the wedge forming a cul-de-sac at the foot of the Mahadeo hills among whose peaks lies the Pachmarhi Plateau, and gradually widens as it extends westwards to the Sonbhadra River where the base of the wedge is some seven miles long. The valley is bounded on the north by the precipitous sandstone scarp of a long spur running west from the main massif of the Mahadeo Range, and rising up to a height of 3,777 feet like a vast wall. The average elevation of the bottom of the valley is about 1,450 feet. To the west of the valley the country is chiefly flat so that it will be gathered that the Bori forest lies in a long funnel-like depression (*see* map in Plate 34).

The Reserve forms part of the Bori Range and it is some 30 miles from the nearest pucca road and railway and about 40 miles from the nearest considerable centres of population, Itarsi and Sohagpur, so that it is comparatively remote.

The peculiar configuration of the Bori valley, open as it is to the west and to some extent to the south and with the abrupt obstacle to the monsoon winds to the north and east, no doubt accounts for the heavy rainfall received. No meteorological data have been recorded in the valley itself but the average annual rainfall at Pachmarhi, only ten miles to the east is about 80 inches, and it seems likely that in the valley the rainfall is still higher, approaching 100 inches. The premonsoon showers are usually experienced as early as the end of May and the heaviest rains come in July and August after which there is a gradual diminution till the monsoon ends in October. In most years there are further small storms occasionally from December to February and heavy dews continue frequently up to


BORI AND ITS ENVIRONS
SCALE 1": 8 MILES.
N
BHOPAL STATE
NERBUDDA R.
TO CALCUTTA
SOHAGPUR
BAGRA
HOSHANGABAD
TO DELHI
ITARSI
FROM BOMBAY
TAKU
TAWA R.
TO MADRAS
MALNIR.
DENWAR.
BORI
PACHMARHI
CHHINDWARA DISTT.
BETUL DISTT.

March so that the forest remains green in Bori for a considerably longer period than does the ordinary teak forest of the Central Provinces.

Records of temperature also are lacking but it is almost certain that the average maxima and minima are lower in Bori than in other places in the neighbourhood at a corresponding altitude. In the monsoon the climate is warm and steamy but the cold weather commences very soon after the end of the monsoon. By the beginning of December there is a definite liability to sharp frosts which persists until mid-February. At the end of December, 1936, ice which formed on still water in the shade did not melt for three days. Cold weather days are warm and bright. In the hot weather, while the days are uncomfortably hot, there is a very appreciable fall in temperature at night. During the hot weather of 1939 the writer stayed for about a month at Bori and always slept inside the Forest Rest House and was glad of a blanket in the small hours, a degree of comfort not enjoyed by many who had retired to Pachmarhi for the hot weather. An unfortunate result of the climate of Bori, however, is that malaria of a virulent type is very prevalent, particularly from September to February.

The underlying rock of the Bori valley consists of sandstones of the Upper and Lower Gondwana series, but there are also large masses of extruded or inter-bedded trap besides sandy shales. The teak flourishes on trap, but is invariably poor and stunted on sandstones. The alluvial soil along the banks of the large *nalas* and of the Bori river produces some exceptionally fine teak forest also but the low hills along both sides of the valley which have trap soil produce the best stands.

Owing to the combined favourable factors of high rainfall, good soil derived from the trap, and the long growing season from May, when the first leaves appear on the teak, till February or early March, the Bori Reserve is one of the finest teak forests in India and, so far as the Central Provinces are concerned, is second only to those of Allapilli in the Chanda District. (*See* Plate 35.)

Since the reservation of the Bori forests in 1862 many eminent persons have visited them. Among the first of whom were Brandis

(later Sir Dietrich) who visited the forest in 1869, specially to inspect the fire protection scheme introduced by Colonel Pearson, and again in 1876, and Schlich (later Sir William) who went to Bori in 1883.

Brandis wrote a comprehensive note on the Bori forests in 1876 in which he remarked that the next most important species after teak was the bamboo, *Dendrocalamus strictus*, which he said had considerably decreased since his first visit in 1869 when the forest had more the appearance of a bamboo forest. This he attributed to a fairly widespread sporadic flowering of the bamboo, which had meanwhile been taking place. This had allowed the establishment of much teak reproduction, which had previously been suppressed. He also remarked that the teak appeared to have little to fear from the bamboo in Bori. This, as will be seen later, was the first allusion to a problem which seriously confronts us at present. The bamboo has still a great importance silviculturally but economically it is still almost as unimportant as in Brandis' day owing to difficulty of export. Next after teak the commonest tree met with, according to Brandis, was *tinsa* (*Ougeinia dalbergioides*). This is still so and forms a valuable addition to our revenue as it often fetches a higher price than teak, and with teak is practically the only export from Bori even to this day. In point of number Brandis placed other species in the following descending series: *saj* (*Terminalia tomentosa*), *dhaura* (*Anogeissus latifolia*), *kusum* (*Schleichera trijuga*) and *bel* (*Aegle marmelos*). Two trees of value, but scarce in Bori he said, were *bijasal* (*Pterocarpus marsupium*) and *shisham* (*Dalbergia latifolia*). The present constitution of the Bori forests is much as Brandis found them in 1876, but the quality of the timber has, no doubt, improved.

Brandis also makes the following observation: "Compared with each kind separately, teak is the dominating tree, but it is much less plentiful than the other kinds taken together." A similar remark appears in a resolution of the Local Government in 1897 approving the introduction of the first Working Plan for the Bori Forests. No doubt this was perfectly true then, but a further 40 years of rigorous fire protection and systematic working since 1897 has evidently wrought a great change for there can be little

doubt, although no complete enumeration of all species has been carried out, that teak now forms fully 50 per cent. of the crop in all those places which can be considered as being favourable to teak forest, that is 70 per cent. of the whole area.

Brandis goes on to say: "And though soil and other circumstances are most favourable to its spread, there is no chance of this forest ever becoming a pure teak forest." Our most recent working shows that this is not likely to prove correct as, apart from bamboos, there is little except teak in the clear-felled regeneration areas. Past selection fellings have also led to a great increase in the proportion of teak.

It is interesting to note that at Pachmarhi the main species met with in the forests of the plateau is sal (*Shorea robusta*) and that there was, until a few years ago, one sal tree at the eastern end of the Bori Valley. Probably others still exist in remote corners and apparently this is the western limit of distribution of sal, which occurs at Pachmarhi and Delakhari in the midst of the teak areas of the Province.

Previous to confiscation in 1859 the Bori forests had been subjected to continuous shifting cultivation or *dahya* by the then considerable local population of Gonds and Korkus. In the *dahyas* some of the larger trees were left standing after pollarding and the rest of the forest ruthlessly cut down and burned. In 1862 when the forest was taken over by the newly formed Forest Department a large number of half-burned logs were lying on the ground. The best of these were collected in depots and aggregated 110,000 cubic feet. The *dahya* cultivation was then rigorously suppressed and systematic fire protection was introduced in 1864 over the whole forest. In 1914 Colonel Pearson, still going strong at over 90, wrote what he called: "the Jubilee letter of fire protection in India," to Jollye who was then marking his first coupe in Bori. Probably this is the first instance of systematic fire protection measures being adopted in any part of the tropics. In the following year, 1865, the Bori forest was notified as a Reserve under the Forest Act. The local population were induced to settle elsewhere and only two villages were settled in the Reserve. These, however, were deserted in 1871 and since that time settlement of villages has been a precarious business.

The condition of the forests at this time was lamentable, large areas were almost bare, young growth quite inadequate and large trees mostly unsound. The visit of the Inspector-General of Forests, Sir Dietrich Brandis, in 1869, led to the appointment of a "Scotch Forester," Mr. Davidson, who was placed in resident charge of the Reserve with instructions to demarcate and divide the forest into blocks, carry out improvement fellings and take up plantation work in blanks and abandoned *dahyas*. Apparently he did no improvement fellings but he did make two small plantations, one in the bottom of the valley near the Bori River which failed, presumably due to frost damage, and one a little further up the slopes in a frost-free locality which succeeded. Unfortunately the soil conditions of this plantation and possibly subsequent lack of thinning have not allowed it to develop as well as it might have done and now at about 70 years of age the best stems are about 75 feet in height with a diameter of 12 to 14 inches.

The original Bori Reserve, east of the Sonbhadra River (old Bori as it was called), had an area of $37\frac{1}{2}$ square miles but in 1878 an area of $24\frac{1}{2}$ square miles west of that river was added as it contained considerable patches of similar forest amongst a larger area of poor open grassy scrub. This was known as New Bori and was included purely for convenience of working the good patches which were chiefly near the banks of the Sonbhadra.

Slight operations were carried out between 1862 and 1865 such as extracting charred remains and girdling but there was practically no felling done in the Bori forests (Old and New) until 1889. Thus there was a most valuable period of rest and recuperation which was only interrupted up to 1895 by some removal of mature teak and *tinsa* over 18 inches in girth taken from a prescribed area each year. Even this was considered too much and the operations were stopped until the first regular Working Plan was introduced in 1897. Thus for 25 years the forests were almost unworked.

The Working Plan of 1897 was drawn up by Mr. E. E. Fernandez, Conservator of Forests, Northern Circle, Central Provinces, in consultation with Mr. Thomas who was the D. F. O., Hoshangabad, and was approved by Mr. B. Ribbentrop, C.I.E., Inspector-General of Forests. It embraced both Old and New Bori.

In describing the condition of the forest at that time it was observed that blanks were filling up with self-sown seedlings and that the proportion of teak in the forest was increasing, though still deficient. Some desultory climber cutting done from time to time since 1868 had also effected some improvement, but the main cause of the recovery of the forest was undoubtedly the prohibition of *dahya*, fire protection and grazing control. In discussing the possibilities of the forest Fernandez remarked that six-sevenths of the total area was capable of producing sound teak 80 to 100 feet in height and over six feet g.b.h. Brandis notes that in 1869 the largest teak tree felled on record was over nine feet g.b.h. but, like all the large trees, was hollow. The writer, in the course of an enumeration recently undertaken, came across teak of over 12 feet g.b.h. but these, likewise, were badly decayed. Although Brandis had advocated that ring countings should be carried out whenever possible, this had been badly neglected and only figures collected by him in 1869 from trees in depots were available to Fernandez. These showed that it took 120 years for teak to reach a little over four feet g.b.h. and 200 years to attain six feet. Fernandez assumed that with the then improved conditions these girths would be reached in 100 years and 160 years respectively.

It was agreed that owing to the almost complete lack of local demand from the Bori forests, due to the fact that there were adequate forests accessible to the cultivators of the Nerbudda Valley for their needs, Bori should be worked purely on commercial lines to supply large-sized timber to distant towns such as Jubbulpore, Bhopal and Bombay, etc., by rail from the then nearest railway stations of Sohagpur and Bagra on the Bombay—Calcutta line, a distance of 43 miles from Bori. There was a fair weather cart track from Sohagpur into the heart of the Bori forest at this time but when or by whom it was made is not known.

The objects sought to be attained by Fernandez' plan were:

1. To get rid of misshapen and unsound mature and middle-aged trees as quickly as possible with due regard to markets and control of fellings. In his own words: "we must subject the forest to a course of improvement fellings with a view to the application immediately after of a rational jardinage, *i.e.*, jardinage in which

thinnings and cleanings will claim not less importance than the regeneration fellings and utilization of mature trees."

2. "To make the forests accessible by opening out good roads and devising some cheap method of water carriage to Bagra and Hoshangabad." Here it is of interest to note that water transport had been advocated by Brandis who had considered that the Sonbhadra was useless for the purpose owing to the very deep and narrow rocky gorge where the river passes through the scarp which forms the northern boundary of the forests. Brandis, therefore, advocated carting timber ten miles further west to the small Malni river whence it could be floated to the Tawa river, which is crossed by the main railway line at Bagra. The Sonbhadra scheme has since been investigated thoroughly in 1927 by order of Sir Montagu Butler, who was then Governor of the C. P. It was not found suitable either for floating or for a road. The Malni scheme also was not found feasible. Both rivers are rocky in places and the cost of preparation for floating would be prohibitive.

The Working Plan thus provided for a general scheme of improvement and opening up of the area and, of course, fire protection and grazing control. The forest was divided into three felling series and a felling cycle of ten years fixed, after which the position was to be again reviewed. Unfortunately, the intentions of this Working Plan were never carried out and, instead of light improvement fellings and thinnings being instituted, heavy fellings were permitted. The result was that, up to 1902, when fellings were stopped, only five coupes were worked over.

No further work took place until a new Working Plan was introduced in 1909-10, when the forest except for the five coupes already referred to, was in much the same condition as in 1897, that is to say, fully mature teak were in a minority but there was a splendid crop of middle-aged and young teak which gave great promise for the future. Bamboos appear to have increased again as the writer of the plan, Dunbar-Brander, remarks on their size and number.

Under Dunbar-Brander's Working Plan Bori was excluded, *i.e.*, the whole area west of the Sonbhadra, but the inclusion of at least those compartments abutting on the Sonbhadra River would

appear to have been justified as the forest in them is very similar to the Old Bori type. The Working Plan thus limited its scope to two felling series in the Old Bori forests. Under this Working Plan the improvement fellings, prescribed in 1897, were continued but with the emphatic proviso that no sound teak under six feet g.b.h. was to be removed, except for very special silvicultural reasons. It was still considered that teak had little to fear from bamboos but at the same time the cutting back of bamboos interfering with teak was advocated. Removal of inferior species and badly grown teak was prescribed as well as regular climber cutting.

This Working Plan was to run for ten years, by which time it was hoped that selection fellings might be introduced. However, in the event of insufficient improvement taking place, another cycle of improvement fellings was recommended. It was hardly likely that the number of large trees would have increased appreciably in such a short time and actually we find that the same prescriptions were in 1919 allowed to hold for a second felling cycle and working was continued on the same lines up to 1925 when the possibility of a change in the system of working was discussed. In December, 1925, a new set of provisional prescriptions was drawn up to tide over the time until a new Working Plan could be prepared. This introduced crown thinnings in the interest of the existing crop as its main provision, the aim being a crop of 50 per cent. teak and wherever teak exceeded this proportion other valuable species, such as *tinsa,* were to be given preferential treatment. Reproduction was not to be considered at the expense of a valuable overwood and the advance of teak into bamboo areas or areas of less valuable forest was to be assisted by the opening up of the canopy.

In 1926 the Working Plan branch was inaugurated in the Central Provinces and one of the first areas to be given a new Working Plan was the Bori forest. By this time the condition of the Bori forests was considered ripe for the introduction of a more intensive form of management. The proportion of teak had greatly increased, most of the old malformed stock had been removed, reproduction of teak and other valuable species was not abundant but it was expected that it would spring up in force on the intro-

duction of heavy fellings, and at the time markets for large-sized timber were good. Attracted by the flourishing appearance of the forest and the possibilities of the market it was thought to be a favourable moment to introduce conversion fellings with a view to making the Bori Reserve into an even-aged forest.

The forest was stockmapped by the Working Plan party under Sodhi in 1926-27 and it was decided to begin conversion to Uniform High Forest with a conversion period of 80 years. The forest, this time again including parts of the Dhain Block of New Bori, near the west bank of the Sonbhadra River, was divided into four periodic blocks. The allotment of compartments was done as rationally as possible, considering that it was difficult to differentiate between compartments which were so nearly similar in age and stocking. A regeneration period of 20 years was fixed and the compartments for regeneration in the first half of the first period were enumerated as regards teak and *tinsa* down to two feet g.b.h. The annual yield was then fixed by units. Regeneration was to be as complete as possible giving due regard to such factors as soil, liability to frost damage, landslides, etc. The standing crop was to be removed by stages as seedling regeneration made its appearance. This, however, appeared to be hardly necessary in most places after the plan had been in force for a couple of years. Bamboos were to be cut where necessary but fears were expressed lest the cutting of entire clumps of bamboos over large areas might lead to their extinction. This anxiety is now known to have been unnecessary. The continued contention by many people from Brandis onwards that the teak in Bori had nothing to fear from the bamboo may have been partially true so long as the bamboo was below a fairly continuous canopy but from 1930 onwards the realisation of the immense vigour of the bamboo became clearer and clearer and it is now certain that teak in Bori under a clear-felling system has a very great deal to fear from the bamboo. In fact by 1936 it was tragically clear that in those areas where bamboo was abundant before felling, even if the bamboos were felled at the time of cutting the overwood or later, teak coppice and seedlings, as well as that of all other species, became completely swamped by the bamboo re-growth. It has, therefore, become a

A typical patch of Bori teak forest.

By courtesy: *M. V. Laurie.*

An area under regeneration fellings in 1939. The hills in the background are part of the precipitious scarp.

By courtesy: *M. V. Laurie.*

matter of importance to take vigorous steps against the bamboo if conversion operations are to succeed.

Under the 1928 plan a matter which has caused misgivings is the failure of seedlings to appear after regeneration fellings. This is, no doubt, largely attributable to the bamboos, but even so recruitment of seedlings has been far from satisfactory and it hardly seems possible to carry on without undertaking artificial regeneration operations wherever reproduction is lacking. The 1928 plan was due for revision after ten years but, before the expiry of this period, the urgency of the bamboo problem became so apparent that some experimental changes were made in the prescriptions. Cutting and burning of the bamboo in advance of regeneration fellings was tried in 1937 in the area due for felling in the following year, the bamboos being piled, before burning, on the stools of the clumps. This appeared to be beneficial as re-growth of the clumps was decidedly weaker and recruitment of teak seedlings was seen to increase. It seemed likely from this that the solution of our difficulties might be found in this, or perhaps more drastic action but some planting of areas deficient in established reproduction still appeared advisable.

The writer was at this time occupied in the task of revision of the Working Plan for the whole of the Hoshangabad Division, including the Bori Forests, and in grappling with the dual questions of the bamboo menace and the general regeneration problem. The results of these labours so far as Bori is concerned are still in the melting pot as the whole question of conversion in Bori was reopened. It is contended that conversion is entailing a great sacrifice in Bori, because so much of the growing stock is immature and at a stage of development when it is possibly increasing in value at the maximum rate. The question is whether we ought not to wait until we have reaped the benefit of this rapid increment, the more so because of our apparent failure to cope with the bamboos, and in the meantime to confine operations to limited selection fellings. In order to decide this question, volume outturn, price increment and stump analysis data are being collected in Bori at present and a 20 per cent. enumeration of the growing stock made with girth-*cum*-height classifications of all teak

and *tinsa* over two feet g.b.h. and with a count of all established teak and *tinsa* reproduction below two feet g.b.h. but, over 15 feet in height. The conclusions from the data now collected would not apply to the forest of the future if worked under conversion to uniform and it will be difficult to come to a reliable conclusion as to whether the sacrifice involved by conversion is justified or not. It is generally held that a selection system is not ideal for a light-demanding species like teak and thus treatment of the Bori Forest under the Uniform System would appear to have much to recommend it, provided we can find a method of coping adequately with the bamboo problem and to a lesser extent the problem of inducing natural regeneration. The writer believes, after having seen the results of cutting and burning the bamboos in 1937 in a compartment under regeneration, and the cutting back of some interfering culms in the same area again in 1938 and 1939, that we are on the way to a solution of this problem and that in future, if we can cut the bamboos once or twice well in advance of felling of the overwood and burn them with the slash we shall have practically solved the two problems in one and planting work will be necessary only in very limited areas, though we shall probably have to keep the bamboos down for the first two years. (*See* Plate 36.)

The 1928 plan recommended that artificial regeneration by means of *taungya* should be given a trial where reproduction was deficient. This was done in 1928 and in 1929 over a limited area but, unfortunately, in the first year the site was not well chosen, and frost caused practically a 100 per cent. failure. The area tried in 1929 was successful, being on higher ground, but apparently some local condition of the soil in this area has rendered the rate of growth of the resulting saplings rather slow. The writer saw this area in 1931 when, besides the sown teak, there was a great number of natural *tinsa* seedlings. For some unaccountable reason there is practically no *tinsa* to be seen in 1940 even though the teak is not over-dense.

Until 1926 the exploitation of the Bori forests was done through contractors who removed trees previously marked by the staff of the department. Probably due to poor organisation the contractors removed only the best of the material and a great

amount of waste resulted. It was not, however, a satisfactory method of exploitation of such a valuable forest either from the point of view of utilisation or of silviculture and the present system of complete departmental working is enabling us to give a much greater measure of attention to the needs of the forest. Teak is exported chiefly in the form of adze-dressed squares and otherwise unsaleable poles and branchwood is hand-sawn near the area under exploitation and such is the demand for this sawn material that even such small sizes as two feet six inches by three inches by four inches are produced. *Tinsa* is chiefly exported in the round. Apart from occasional small quantities of such species as *shisham* and *haldu* (*Adina cordifolia*), nothing else is exported from Bori. Recently attempts were made to sell the bamboos and a contractor removed a small number by lorry at royalty of three annas per cent. but soon gave it up owing to the high cost of removing them over a bad road and lack of sales organisation on his part.

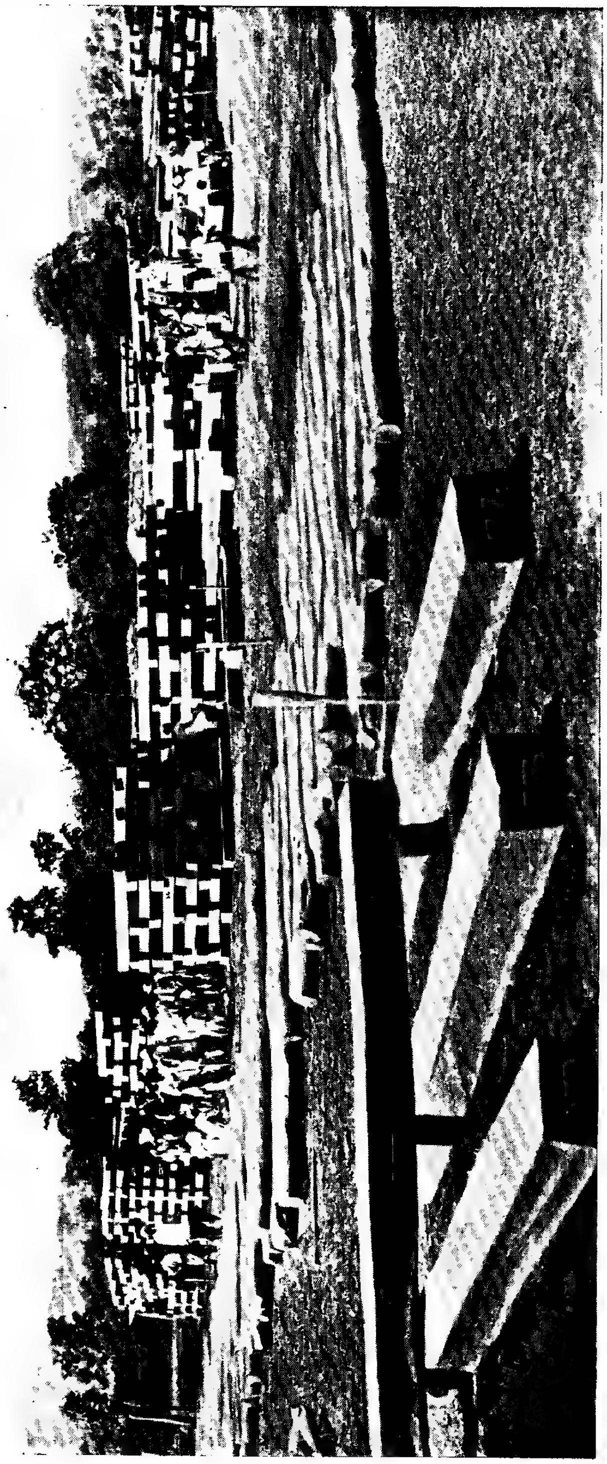
As has already been indicated, the question of transport has always been a vexed one in Bori. The main reason is that Bori lies in a *cul-de-sac* surrounded by uninhabited hills. So there is no demand for a road except for forest produce. (*See* Plate 37.) Within the Bori Reserve itself until about 30 years ago there were practically no roads except a rather poor one running through the centre of the forest. About 1908 the main road in the Reserve was improved and the construction of an export road towards the railway at Sohagpur and Bagra was begun while a few permanent extraction roads to feed the main road in the Reserve were constructed shortly after. Timber, therefore, continued to go out towards Sohagpur for many years but gradually the main outlet shifted towards Itarsi as that place grew in importance as a main railway junction between north and south India. In the early days the quantity of timber removed from Bori was small and the road, which was really nothing more than a fair weather cart-track, was able to stand up to the traffic. Unfortunately, however, almost from the time it leaves Bori it runs over a very sandy tract and as exports increased the surface became worse and worse so that it was a very laborious business to bring out a load of more than about 20 cubic feet on a bullock cart. With the improvement of the market for

Bori teak and the continued deterioration of the road it became necessary to consider metalling. The Public Works Department carried out a survey and gave an estimate for metalling and construction of culverts but the scheme was turned down as being impossible to justify. The matter, however, did not rest there and although funds are difficult to obtain the Forest Department is now metalling the road bit by bit and a great improvement has already been effected. Some idea of the expansion can be gathered from the fact that the average annual outturn from 1890 to 1897 was about 11,000 cubic feet of teak, in 1938-39 it had risen to 68,000 under the conversion system. All the material is nowadays exploited departmentally and is sold in small lots in monthly auctions held by the department at Taku depot, 35 miles from Bori at a station on the Itarsi—Nagpur Branch of the Great Indian Peninsula Railway about 10 miles from Itarsi. (*See* Plate 38.) With a good metalled road out to the depot it would be possible to extract vast numbers of bamboos annually, either for export or to feed a pulp factory, and in addition it would become feasible to bring out large timber of other species of less value than teak and *tinsa*. It is probable that eventually producer-gas lorries will be used for transport and run on charcoal which could be produced in large quantities in Bori from inferior species and slash and with cheap transport would be sold profitably. But until there is a good road to Bori its resources must remain largely unexploited.

A few words about the local inhabitants may be interesting. When the forest was first reserved and *dahya* cultivation prohibited only two small villages were settled and these were deserted in the course of a few years and after that there were occasional settlers from the neighbouring *jagirs*, but not until recently has there been a resumption of regular settlement due to the increased demand for labour. There are two villages now, one at Dhain on the western edge of the Bori Valley and the other at Bori itself, of 10 or 15 huts. The inhabitants of both villages are Korkus of the Kolarean race of aborigines. It is rather strange that this should be so, because most of the forest villagers of the surrounding neighbourhood are Gonds and these Korkus of Bori and a few nearby *jagirdari* villages form an enclave separated by a considerable

A *parao* in the Bori forest. Adze-dressed teak squares being loaded for transport to the sale depot.

By courtesy : *M. V. Laurie.*



Bori teak for sale stacked at Taku depot. The round timber in the foreground is *tinsa.*

By courtesy: *M. V. Laurie.*

distance from the main body of the Korku country, which generally lies further west.

The fauna of the Bori Valley is on the whole typical of the denser forests of the more remote parts of the Central Provinces, that is to say, tiger and panther are common; bison, sambhar, barking deer, four-horned-antelope, pigs, hyænas, sloth bear, jungle cats and red dogs all well represented. Some of the rarer animals are also found, such as Malabar squirrels, ratels and pangolins. Peafowl and jungle fowl are scarce compared with other parts of Hoshangabad Division. For the last ten years the Bori Reserve has formed part of the Bori Game Sanctuary, but there is little doubt that animals are more numerous in the western part of the sanctuary where there is a poor open type of mixed forest than they are in the Bori Valley itself where the dense bamboo jungle does not seem to be an attractive haunt for animals.

BRIEF PRECIS

The valuable Bori teak forests were the first in India to be reserved and were visited by well- known forest officers from the earliest days of reservation. The notes which they left and working plans of later years give a fairly complete history of the forests up to date which may be of interest to those who have visited Bori. Fire Protection in Bori was probably the earliest in any part of the tropics. The gradual improvement of the forest after the suppression of shifting cultivation is traced through these working plans.

THE GENUS HYSTRIX MOENCH. IN INDIA

BY N. L. BOR

The late A. S. Hitchcock, the American agrostologist, has given reasons in the American Journal of Botany, 21 (1934) 133, why the genus *Asperelia* Humb. must give way to *Hystrix* Moench. Briefly stated the reasons are these; *Asperella* Humb. (1790) is considered to be simply a spelling variant of *Aspnella* Schreb. (1789), which is itself a synonym of *Leersia* Sw., and as such is invalid, being a later homonym. *Hystrix* Moench, Meth. (1794) 294 is the next generic name available and is to be adopted.

There is one species of *Hystrix* in India, which appears under the name of *Asperella Duthiei* Stapf in the Flora of British India. The combination under *Hystrix* Moench. is made here and a full description of the grass is given as the descriptions given by Stapf in the Flora of British India and in Hooker's Icones are extremely meagre.

HYSTRIX DUTHIEI (Stapf) Bor, comb. nov. Syn. *Asperella duthiei* Stapf in Hook. f. Fl. Brit. Ind. VII (1897) 375 et Hook. Ic. Pl. tab. 2525.

A perennial grass. Culms terete, up to 90 cm. tall, erect from a shortly geniculate base where rooting takes place at the lowest one, two or three nodes; lower nodes rather close, upper wide apart. Stems much striate, glabrous or hairy, especially below the inflorescence, smooth or very minutely scaberulous. Leaf-blades broadly-linear or narrowly elliptic in shape, contracted and rounded at the base to its insertion on the sheath, tapering at the apex to a long acuminate tip, many-nerved, with the midrib visible as a thin white line, up to 20 cm. long by 2 cm. wide at the broadest part which is in the middle of the blade, covered on the upper surface with sparse villous hairs which appear to arise from the numerous longitudinal veins, very rough below, soft and flaccid, dark green in colour, margins minutely serrulately scabrid; sheaths shorter than the internodes, rather loose and slipping from the culms, sulcate-striate, smooth, glabrous or covered with a short curled pubescence; the nodes are covered with a dense appressed pubescence; ligule membranous, truncate, up to 4 mm. long, covered on the back with a minute pubescence.

Inflorescence a terminal spike, often curved, up to 15 cm. long. Rhachis flattened, or keeled on the back of the segment opposite a pair of spikelets, flexuous, pubescent on the surface away from the spikelets, glabrous next to them, carrying the spikelets in pairs in notches which are set alternately about 6 mm. apart. Spikelets lanceolate in shape, long-awned; backs of the lemmas external. At each notch of the rhachis are to be found two stout, short, adjacent pedicels. Pedicels very short ending above in one or two blunt protuberances, or one or both of these protuberances produced into a

subulate awn up to 11 mm. long. These protuberances or the awns represent the lower and upper glumes, the awn being rarely developed in the case of the upper spikelets but are usually to be found in the lower spikelet. Lower lemma jointed very obliquely to the rhachilla by a very conspicuous hairy callus (which is 1 mm. long, contracted below the base of the lemma), 9 mm. long, elliptic-lanceolate in shape when flattened, 7-nerved (conspicuously 5-nerved at the tip), rounded on the back and narrowed into an antrorsely scabrid awn 35 mm. long, glabrous on the back, spinulose between the nerves on the back particularly at the sides towards the apex; palea elliptic-lanceolate in shape, nearly 10 mm. long, bifid at the apex, 2-nerved; nerves parallel, scabrous above, very close together; back of palea sunk between the nerves to accommodate the prolongation of the rhachilla. Ovary obovoid, densely covered with golden hairs on the apex; styles 2, short; stigmas plumose. Stamens 3; anthers 4 mm. long, linear. Lodicules 2, obovate, ciliate. Rhachilla produced, scabrid, sunk between the two nerves of the palea, up to 4 mm. long, crowned by a rudimentary lemma, or by an awn up to 6 mm. long, or even carrying a second lemma, which is similar to the first but smaller. The lowermost spikelets in a spike are often rudimentary and represented by long or short awns.

This interesting grass, in so far as the material in the Dehra Dun Herbarium is concerned, seems to be confined to the State of Tehri-Garhwal between 7,000 and 8,000 ft. Recently this grass has been collected by a student of the Indian Forest College (V. P. Agarwala) near Khatyan, Chakrata Division.

EXPERIMENTAL AFFORESTATION OF WATER-LOGGED AREAS IN THE PUNJAB

By R. S. Chopra

The network of irrigation canals, no doubt, constitutes a great boon to the inhabitants of the parched Punjab plains, but it has not been altogether an unmixed blessing. The running of canals has brought in its train a minor evil, namely, that of water-logging. Thousands of acres of good land along the main canals have been lost to cultivation through genuine water-logging caused by the

cumulative rise in the subsoil water table, not to mention the huge acreage rendered sterile through the appearance of *thur, i.e.*, the accumulation of alkali salts on the surface. The reclamation of these water-logged areas has been a subject of concern to the Government. Where expert irrigation engineers and soil scientists were employed in finding a solution to the problem, the Forest Department was also asked to study the possibility of reclaiming the water-logged areas by tree planting. On the recommendation of the Water-logging Committee, Punjab, a small block of 57 acres was handed over to the Department in the year 1932 for the purpose. The history of afforestation of the area is sketched in this note.

Situation, past history and description of the area.—The area is known by the name of Pakhowal *jhil*. It is situated in Bhalwal Tehsil in the Shahpur District about a mile towards the east of Pakhowal Railway Station on the Malakwal-Sargodha branch line of the North-Western Railway, and forms part of Daphar Range in the Lahore Forest Division. The Lower Jhelum Canal, 150 feet wide, flows to its south-east within a distance of one mile.

Originally the area formed part of the Civil *rakh* (dry scrub jungle) Miani where the spring water level, prior to the construction of canal, was about 30 feet below the ground surface. The opening of canal in the year 1916 was followed by a rapid rise of water table due to seepage of the canal water. About the year 1922 the water table had risen to the ground surface and pools had formed in depressions. By 1929 a fairly larger tract of land, nearly three square miles in area, had got submerged under water and it came to be known as Pakhowal *jhil* (lake) where sportsmen enjoyed excellent duck shooting. In 1930-31 steps were taken to drain off the *jhil* by digging cross drains, etc. As a result most of the land was reclaimed in a couple of years and brought under cultivation. The unreclaimed portion was handed over to the Forest Department for tree planting. This bit at the time was covered with a dense matty growth of marsh grasses and was not completely drained. In the summer of 1933 it got submerged to a depth of six inches. It was only from the year 1934 that water did not appear on the surface.

The soil of the area was sandy loam with a hard upper crust and a layer of sand about one foot below ground which facilitated

percolation of canal water. The climate was typical of Punjab plains, viz., poor rainfall, intense heat in summer, shade temperature rising as high as 118° F, and frosty cold in winter.

Afforestation.—A regular scheme for stocking the area with Eucalyptus species was prepared by Khan Fazal Mohammad Khan, D. C. F., and it came into operation in the year 1932, soon after the area was placed under the control of the Forest Department. At first the Forest Department undertook work on behalf of the Irrigation Department but in 1934 the area was transferred to the Forest Department and declared as a reserved forest. The Eucalyptus species tried included *E. rostrata, E. tereticornis, E. hemiphloia* and *E. saligna*. Out of these, *E. rostrata* proved more successful and was finally selected for the plantation. The area was fenced with barbed wire before planting. The first year's planting was done with Eucalyptus "stumps" imported from Chhanga Manga plantation but later a technique of transplanting four to six months old nursery seedlings was developed as described below. An area of 38 acres has been successfully planted with this technique up to the end of 1938.

Nursery Work.—The Eucalyptus seed is very minute and requires a careful handling for stock raising. The plants are raised in bottomless clay cylinders, six inches deep and three inches wide. The compost used is the ordinary clayey loam soil mixed with leafmould in equal proportions or a light soil prepared by mixing clayey loam soil canal silt and leafmould in the rough proportion of 2 : 1 : 1 by volume. Rectangular nursery beds, three feet wide and any convenient length, are dug out about four inches deep, the pots are arranged in beds in rows and filled with the compost. Water is then let into the beds and when the moisture has risen to the surface soil in the pots, a small quantity of Eucalyptus seed is broadcast in each pot and lightly covered with fine powdered earth. Subsequent watering is also done by flooding the nursery beds so that the moisture rises by percolation in the pots and the seed remains undisturbed. Germination takes place after a week and is invariably profuse with fresh and good seed. The seedlings attain a height of about two inches in a month when they are pricked out leaving two or three seedlings in each pot. The spare stock

is used in planting failed or fresh pots. The stock becomes fit for planting after four months when the seedlings are about six inches tall. The best time for nursery sowings has been experienced to be the middle of February when the weather warms up. Germination was quicker and success high with seed sown at this time of the year. The plants become fit for transplanting in the following June-July. In the *jhil* area early planting in March-April had to be done out of necessity as mentioned hereinafter; therefore nursery sowings were done in October as well to get stock in time for planting. But the results were comparatively poor.

Grasshoppers formed the chief nursery pest, making a meal of tender leaves and shoots. Insecticides proved of little avail in checking their attack. The young hoppers were no doubt killed but the mature ones would hop off and revisit in the beds when the effect of insecticide was over. Their attack, however, ceased when the leaves became tough in time.

Planting.—The preliminary site preparation consists in stubbing out coarse grasses and laying out the compartment roads. This is done in winter before planting. The planting is done in March-April or July-August, generally in the latter season. Early planting was no doubt accompanied with a distinct gain in height growth of plants during the first season but it had its limitations and disadvantages. In the first place it was difficult and expensive to raise sufficient well developed stock for planting from October sowings and secondly casualties were heavier among the transplants in the ensuing hot weather. April planting had its use in the beginning (1932 to 1934) when water used to ooze out on the surface in summer. Under such conditions plants put out in July-August suffered directly through submergence, whereas April transplants withstood water-logging better having put on growth to enable them to hold their head above water.

As for method of planting, the plants are put out with pots in requisite holes dug out 10 by 10 feet apart. The pots are withdrawn in the first winter, nearly six months after planting when the plants have taken a firm foothold in the ground. Mound planting and ridge planting were also tried on an experimental scale. The methods proved useful when water flowed overground but as a

whole their disadvantages outweighed the gain. The cost on watering in the dry season was increased and a heavier mortality resulted owing to the inability of the tender plants to push their roots through the hardened soil surface.

Tending.—The plantation requires a careful and constant attention during the first two years. Watering, weeding and hoeing, pruning and replacement of failures form the main tending operations. The plants are hand-watered for the first two years after planting. The operation is fairly simple though expensive. The water level is at three to four feet below ground. *Kachcha* wells about four feet in diameter are dug out at appropriate places in the area in hand from where water is carried to individual plants in buckets. Watering is done daily for the first three months after planting, then on alternate days for a couple of months and later weekly till the end of November. No watering is done in December and January. Watering is again resumed in February. In the second year plants are watered weekly during February-March, bi-weekly in April-May and on alternate days in the hot month of June! Thereafter watering is reduced to once a week or so till the end of November. Watering in the second year is done by selection. Only weak plants below four feet in height are watered. Vigorous plants which have attained a height of four feet and over are usually able to tap the subsoil water and do not need artificial irrigation.

Weeding round the plants including removal of rank growth of coarse grasses is essential to give the plants a good start. Usually three to four weedings in the first year and one or two in the second year are required. Frequent hoeing of the soil in pots in the course of watering is necessary for effective irrigation. The surface soil becomes hard and an impermeable crust is formed on top through the accumulation of saline matter. Consequently water fails to percolate to any depth unless the soil is thoroughly loosened.

Pruning has for its object the reduction of forked leaders to give the plants a healthy and straight start. Boles of older plants are also cleaned to a height of six feet.

The failures in planting are replaced the following year. Speedy replacement of failures is very important. Eucalyptus, being a fast

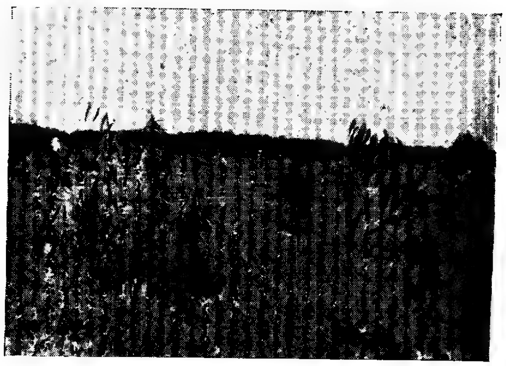
growing tree, the plants put out subsequently fail to catch up if the operation is unduly delayed. Failures usually amount to 25 to 30 per cent. in the first year and 5 to 10 per cent. in the second year. White ants, rats, *kallar*, (saline incrustation), matted growth of *dab* grass (*Eragrostis cynosuroides*) and insolation are the contributory causes of mortality to which may be added submergence which took a heavy toll in the first two years of planting.

Cost of Planting.—The total expenditure incurred on planting 38 acres up to the end of the year 1939 comes to Rs. 2,206, excluding the sum of Rs. 512 initially spent on barbed-wire fence round the area. The planting cost, therefore, works out to Rs. 58 per acre which may be roughly apportioned to different operations as under:

	Rs.	a.	p.
1. Stock raising in the nursery including pot sowing, watering and weeding, etc. ...	4	0	0
2. Carting of plants from nursery to the planting site, four miles	1	0	0
3. Planting including digging of holes ...	2	0	0
4. Watering for two years (first year Rs. 22, second year Rs. 8)	30	0	0
5. Weeding, hoeing and stubbing out grass for two years	3	8	0
6. Pruning	0	8	0
7. Miscellaneous including layout of compartment roads, etc.	2	0	0
8. Restocking of failures, one-third of items 1 to 7 above	15	0	0
Total ...	58	0	0

The net cost of raising the plantation is, however, considerably less, for a revenue of Rs. 1,692 has been realised (1932 to 1939) from grazing and grass cutting, etc., over the area. Grazing was permitted in the unplanted area and grass cutting from the planted area. Offsetting this amount against the gross expenditure, the net cost on establishing the plantation is reduced to Rs. 13 per acre. This, of course, does not take into account the compound interest charges. Let some compound-interest fan indulge in this healthy exercise.

GROWTH OF EUCALYPTUS ROSTRATA IN PAKHOWAL JHIL AREA



2-year-old crop. Height 4 to 6 feet.

4-year-old crop. Average height 16 feet.

6-year-old crop. Height 31 feet. D.B.H. 3.1 inches.

7-year-old crop. Height 37 feet. D.B.H. 3.8 inches.

Growth of Eucalyptus.—The following table gives the rate of growth of *E. rostrata* in the *jhil* area and is based on the measurement of 40 to 70 plants along the diagonal of each compartment planted in different years.

Age Years		Average *D.B.H.* Inches	Average *height* Feet
1	...	...	2
2	...	...	4
3	...	0.7	8
4	...	1.5	16
5	...	2.7	27
6	...	3.1	31
7	...	3.8	37

The growth is not up to the mark. Ordinarily *E. rostrata* is known to be a fast grower. In Chhanga Manga irrigated plantation a height of 52 feet and a D.B.H. of five inches has been recorded for the species at the age of five. In the *jhil* area high salinity of surface soil and presence of a layer of sand below appear to have considerably hampered its growth. Perhaps *Swamp Mohagany* (*E. robusta*) would have done better instead.

Miscellaneous.—It is rather difficult to foretell the financial return from such a small Eucalyptus plantation when the species is alien to the province, nevertheless there appears to be little doubt that the plantation will do more than meet its formation cost. At any rate, it has fulfilled the object of reclaiming the water-logged area. The water level is now about four feet below ground and Eucalyptus appears to have paved the way for the introduction of other species. In fact, trials are already afoot for the introduction of sissoo and mulberry, the more valuable species in the market. *Kikar* (*Acacia arabica*) has already been successfully introduced in the form of a hedge round the plantation but, owing to its frost-tender habit, there is some doubt if it will grow so well in a closed crop.

Conclusion.—The plantation (*see* Plate 39) furnishes a successful demonstration of the value of tree planting in water-logged areas. Creation of permanent tree-belts along the main canals is, therefore, calculated to appreciably reduce the water-logging hazard. Such plantations will, in addition, form a potential source of revenue to the Government and will greatly ease the acute problem of timber and fuel supply in the rural areas.

STATEMENT OF WILD ANIMALS SHOT IN SOME OF THE INDIAN

All-India serial number.	Species.	Ajmer-Merwara.	Assam.	Bengal.	Bihar.	Bombay.	Burma.
1a	Tiger ..	..	16	42	6	30	92
1b	Tigress ..	..	5	15	..	12	..
2	Leopard or panther ..	1	16	37	3	54	50
3	Wild cats (species to be given if known).	..	..	34	..	..	..
4	Lynx ..	..	..	..	..	..	..
5	Hunting leopard or cheetah.	..	..	..	..	..	..
6	Hyena ..	..	..	..	1	..	..
7	Wolf ..	..	..	..	..	..	..
8	Wild dog ..	..	..	2	3	1	73
9	Martens ..	..	..	..	..	..	..
10	Ratel ..	..	..	..	..	..	..
11	Brown bear ..	..	..	..	..	..	..
12	Himalayan black bear ..	..	..	5	..	..	174
13	Malayan bear ..	..	..	..	..	..	..
14	Sloth bear ..	..	13	..	5	8	..
15	Wild elephant ..	..	38	21	..	18	681
16	Rhinoceros (species to be given).	..	2 (unicornis)	..	..	..	..
17	Gaur or bison ..	..	..	..	2	19	20
18	Goyal or mithan ..	..	..	..	..	..	..
19	Banting or tsine ..	..	..	..	..	..	..
20	Wild buffalo ..	..	2	..	..	..	..
21	Urial or sharpu ..	..	..	..	..	..	..
22	Bharal or blue sheep ..	..	..	..	..	..	..
23	Ibex ..	..	..	..	..	..	..
24	Markhor ..	..	..	..	..	..	..
25	Tahr ..	..	..	1	..	..	..

PROVINCES, INDIAN STATES AND BURMA DURING 1938-39

C. P. and Berar.	Coorg.	Madras.	Orissa.	Punjab.	U. P.	Jammu and Kashmir State.
115	11	20	14	..	62	..
..	..	3		..	42	..
84	8	34	29	20	117	52
..	..	10	2	3	29	..
..	..	..	..	..	..	1
..	48	1	..	..	..	..
10	..	..	1	2	12	..
..	..	..	..	1	..	50
26	7	55	4	..	12	..
..	..	..	..	..	15	..
..	..	..	..	..	1	..
..	..	1	..	2	..	9
	1	..	..	8	8	27
29	..	..	..	..	..	..
	..	2	15	..	20	..
..	3	5	..	..	..	..
..	..	..	..	..	..	..
18	2	25	2	..	..	..
..	..	..	..	..	..	..
..	..	..	..	..	..	..
..	..	..	..	..	..	..
..	..	..	..	8	..	5
..	2	..	..	4	..	16
..	..	..	..	3	..	10
..	..	..	..	..	..	9
..	..	..	..	..	..	..

Statement of Wild Animals Shot in some of the Indian

All-India serial number.	Species.	Ajmer-Merwara.	Assam.	Bengal.	Bihar.	Bombay.	Burma.
26	Nilgiri wild goat or Nilgiri ibex.	..	..	..	..	..	..
27	Serow or Himalayan goat-antelope.	..	1	12	..	..	6
28	Goral ..	..	..	4	..	..	..
29	Nilgai or blue bull ..	8	..	..	..	18	..
30	Four-horned antelope ..	..	..	..	..	..	..
31	Black buck ..	..	..	..	..	..	..
32	Indian gazelle or chinkara.	..	..	..	..	..	..
33	Barking deer or kakar ..	..	16	251	7	3	246
34	Kashmir stag or hangul	..	..	..	..	..	..
35	Swamp deer or gond or barasingha	..	..	..	..	..	..
36	Brow-antlered deer or thamin.	..	..	..	..	..	10
37	Sambar ..	..	8	80	14	17	241
38	Cheetal or spotted deer or axis deer.	..	..	528	5	13	..
39	Hog deer or para ..	..	8	16	..	..	23
40	Musk-deer ..	..	..	..	..	..	..
41	Mouse-deer ..	..	..	..	..	..	..
42	Pangolin ..	..	..	..	..	..	..
43	Crocodile (muggar) ..	..	..	14	..	..	..
44	Gharial ..	..	..	6	..	..	..
45	Python ..	..	..	..	..	..	..
46	Others (species to be given).	9 (pigs)	1 (wild pig)	449 (wild pigs, jackals and fishing cat)	13 (wild pigs, jackals and hare)	545 (wild pigs)	303 (pigs)

Provinces, Indian States and Burma during 1938-39—Concluded

C. P. and Berar.	Coorg.	Madras.	Orissa.	Punjab.	U. P.	Jammu and Kashmir State.
..	..	10	..	..	..	..
..	..	..	..	..	1	..
..	..	..	..	44	40	2
101	..	..	2	37	41	..
..	..	2	1	..	9	..
	..	6	..	..	7	..
92	..	..	..	..	3	1
	..	17	26	1	82	..
..	..	..	..	..	..	..
3	..	..	..	..	21	2
..	..	..	..	..	..	..
122	2	20	48	..	129	..
92	4	43	37	2	254	..
..	..	..	..	10	19	..
..	..	..	..	1	..	..
..	..	..	..	..	..	..
..	..	..	..	..	..	..
3	..	3	..	..	15	..
..	..	..	..	..	..	..
..	..	..	..	..	3	..
959 (pigs)	..	20 (pigs)	32 (30 pigs, 1 wild sheep, 1 hare)	110 (107 pigs, 1 jackal, 2 porcupine)	1,252 (otter, pigs, porcupine, etc.)	26 (Tibetan Antelopes, otter, etc.)

TIMBER PRICE LIST FOR JULY-AUGUST, 1940
(INDIAN STATES)
(ISSUED MONTHLY BY THE FOREST RESEARCH INSTITUTE).

Trade or common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Baing ..	*Tetrameles nudiflora* ..	Cochin ..	Logs ..	
"	"	Travancore ..	Logs (Rejected)	Re. 0-5-6 per c. ft.
Benteak ..	*Lagerstrœmia lanceolata*	Cochin ..	Logs ..	
" ..	" ..	Mysore ..	Logs ..	Re. 0-12-6 per c. ft.
"	"	Travancore ..	Logs ..	Re. 0-11-2 per c.ft.
Bijasal ..	*Pterocarpus marsupium*	Barwani ..	Logs ..	Re. 0-8-0 per c.ft.
" ..	" ..	Cochin ..	Logs ..	
" ..	" ..	Dhar ..	Logs ..	Re. 0-6-0 to 0-8-0 per c.ft.
" ..	" ..	Hyderabad ..	Logs ..	Re. 0-14-0 to 1-12-0 per c.ft.
" ..	" ..	Indore ..	Beams 14′×18″	Re. 0-8-0 each.
" ..	" ..	Mysore ..	Logs ..	Rs. 1-3-0 to 1-11-0 per c.ft.
" ..	" ..	Patna ..	Logs ..	Re. 0-8-0 to 0-12-0 per c.ft.
" ..	" ..	Travancore ..	Logs ..	Re. 0-15-11 per c.ft.
Deodar ..	*Cedrus deodara* ..	Patiala ..	Sleepers 10′×10″×5″ ..	Rs. 7-4-0 each.
Dhupa ..	*Vateria indica* ..	Cochin ..	Logs ..	
Gamari ..	*Gmelina arborea* ..	Tripura ..	Logs ..	Rs. 1-4-0 to 1-12-0 per c.ft.
Gurjan ..	*Dipterocarpus* spp. ..	Cochin ..	Logs ..	
" ..	" ..	Tripura ..	Logs ..	Rs. 1-0-0 to 1-4-0 per c.ft.
Haldu ..	*Adina cordifolia* ..	Barwani ..	Logs ..	Re. 0-6-0 per c.ft.
" ..	" ..	Bansda ..	Logs ..	Rs. 23-0-0 to 50-0-0 per ton.
" ..	" ..	Banswara ..	Logs ..	Rs. 1-4-0 to 10-0-0 per log.
" ..	" ..	Bhopal ..	Logs ..	Re. 0-7-0 to 0-9-0 per c. ft.
" ..	" ..	Cochin ..	Logs ..	
" ..	..	Dhar ..	Logs ..	Re. 0-4-0 per c.ft.
" ..	" ..	Mysore ..	Logs ..	Re. 0-12-0 per c.ft.
" ..	" ..	Patna ..	Logs ..	Re. 0-6-0 to 0-8-0 per c.ft.
" ..	" ..	Travancore ..	Logs ..	Re. 0-10-0 per c.ft.
Hopea ..	*Hopea parviflora* ..	Cochin ..	Logs ..	
" ..	" ..	Travancore ..	Logs ..	Rs. 1-2-2 per c.ft.
Indian Rosewood ..	*Dalbergia latifolia* ..	Barwani ..	Logs ..	Re. 0-12-0 per c.ft.
" ..	" ..	Bansda ..	Logs ..	Rs. 39-0-0 to 50-0-0 per ton
" ..	" ..	Cochin ..	Logs ..	
" ..	" ..	Dhar ..	Logs ..	Re. 0-8-0 to 1-0-0 per c.ft.
" ..	" ..	Kishengarh	Logs ..	
" ..	" ..	Mysore ..	Logs ..	Rs. 1-8-0 to 2-11-0 per c.ft.
" ..	" ..	Patna ..	Logs ..	Re. 0-8-0 to 0-12-0 per c.ft.
" ..	" ..	Travancore ..	Logs ..	Re. 0-10-9 to 1-6-11 per c.ft.

Trade or common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Irul ..	*Xylia xylocarpa* ..	Cochin ..	Logs	
" ..	" ..	Travancore ..	Logs ..	Re. 0-12-5 per c.ft.
Kindal ..	*Terminalia paniculata* ..	Cochin ..	Logs ..	
" ..	" ..	Mysore ..	Logs ..	Re. 0-11-0 per c.ft.
" ..	" ..	Travancore ..	Logs ..	Re. 0-11-2 per c.ft.
Laurel ..	*Terminalia tomentosa* ..	Barwani ..	Logs ..	Re. 0-6-0 per c.ft.
" ..	" ..	Bansda ..	Logs & squares	Rs. 13-0-0 to 36-0-0 per ton.
" ..	" ..	Bhopal ..	Logs ..	Re. 0-12-0 to 1-0-0 per c.ft.
" ..	" ..	Cochin ..	Logs ..	
" ..	" ..	Hyderabad ..	Logs ..	Re. 0-12-0 to 1-2-0 per c.ft.
" ..	" ..	Indore ..	Sawn material	Re. 1-4-0 per c.ft.
" ..	" ..	Mysore ..	Logs ..	Re. 0-13 0 per c.ft.
" ..	" ..	Patna ..	Logs ..	Re. 0-6-0 to 0-10-0 per c ft.
" ..	" ..	Travancore ..	Logs ..	Re. 0-13-3 per c.ft.
Mesua ..	*Mesua ferrea* ..	Cochin ..		
" ..	" ..	Tripura ..	Logs ..	Rs. 1-8-0 to 2-0-0 per c.ft.
Sal ..	*Shorea robusta* ..	Cooch Behar	Logs & scantlings	Re. 0-8-0 to 1-12-0 per c.ft.
" ..	" ..	Patna ..	Logs ..	Re. 0-8-0 to 0-12-0 per c.ft.
" ..	" ..	Tripura ..	Logs ..	Re. 1-0-0 to 1-8-0 per c.ft.
Sandan ..	*Ougeinia dalbergioides* ..	Bansda ..	Logs ..	Rs. 17-0-0 to 65-0-0 per ton
" ..	" ..	Patna ..	Logs ..	Re. 0-8-0 to 0-12-0 per c.ft.
Semul ..	*Bombax malabaricum* ..	Banswara ..		
" ..	" ..	Cochin ..	Logs ..	
" ..	" ..	Cooch Behar	Logs & scantlings	Re. 0-2-0 to 0-12-0 per c.ft.
"	" ..	Rampur ..	Planks 6′ × 1′ × 1¼″ ..	
" ..	" ..	Travancore ..	Logs Rejected	Re. 0-5-0 per c.ft.
" ..	" ..	Tripura ..	Logs ..	Re. 0-5-0 per c.ft.
Sissoo ..	*Dalbergia sissoo* ..	Banswara ..		
" ..	" ..	Cooch Behar	Logs & scantlings	Re. 0-8-0 to 1-12-0 per c.ft.
" ..	" ..	Hyderabad ..	Logs ..	Re. 1-0-0 per c.ft.
" ..	" ..	Rampur ..	Planks 6′ × 1′ × 1¼″ ..	
Teak ..	*Tectona grandis* ..	Barwani ..	Logs ..	Re. 0-8-0 to 1-0-0 per c.ft.
" ..	" ..	Bansda ..	Logs ..	Rs. 18-0-0 to 65-0-0 per ton.
" ..	" ..	Banswara ..	Logs ..	Rs. 1-8-0 to 4-0-0 per log.
" ..	" ..	Bhopal ..	Logs ..	Re. 1-0-0 to 1-10-0 per c.ft.
" ..	" ..	Cochin ..	Logs ..	
" ..	" ..	Indore ..	Sawn material	Re. 0-15-0 to 1-4-0 per c.ft.
" ..	" ..	Mysore ..	Logs ..	Rs. 1-12-7 to 2-13-0 per c.ft.
" ..	" ..	Travancore ..	Logs ..	Re. 0-12-7 to 1-13-3 per c.ft.

only since 1931, resulting in profuse natural regeneration. Four thinnings are done during the 30-year rotation, leaving a final crop of 30 trees per acre.—*Jagdamba Prasad.*

TREVOR, SIR GERALD. *Chir in Chandars. Ind. For. LXV* (11): 694, 1939.—Suggests trying *Pinus caribaea* instead of *chir* (*Pinus longifolia*) in frosty grassy blanks (chandars) in *Shorea robusta* forests.—*Jagdamba Prasad.*

WRIGHT, H. L. *Forestry Beyond the Indus*—III. *The Forests of Swat Kohistan. Ind. For. LXV* (7): 389—393, 4 *pls.*—The highland deodar forests of Swat are controlled by the Forest Department. In 1926 the forests were examined by an Indian Forest Service Officer. They were demarcated in 1928 and all deodar was declared State property. The forests are worked under a working plan prepared in 1931. Export is mostly in the form of sleepers.—*Jagdamba Prasad.*

WRIGHT, H. L. *Forestry Beyond the Indus*—IV. *The Gilgit Forests. Ind. For. LXV* (8): 467—471, 4 *pls.*, 1939.—Gilgit is part of Kashmir but not under the State Forest Department. In 1936 circa the country was handed over to the Government of India for management, but only the trans-Indus forests came under the Political Agent. The chief economic species are the spruce (*Picea morinda*), the blue pine (*Pinus excelsa*) and Chilgoza (*Pinus gerardiana*). The forests have no commercial importance, but need organisation and control.—*Jagdamba Prasad.*

(*To be continued.*)

EXTRACTS

SOIL EROSION CAUSED BY WIND

BY R. MACLAGAN GORRIE, D.SC.

Somewhere above the dust, gloom and grit of the dust-storm, the sun is shining. For want of adequate protection on some land surface, the wind has whipped up the loose soil and carried it many miles to make life hideous for the dwellers in some distant city. Somewhere it will come to rest. Somewhere wind-transplanted seeds may lodge and grow, but the sower will not be the reaper.

We have been asked to explain the significance for India of wind erosion. Roughly one may say that wherever there are dust-storms there is wind erosion; a fairly large part of India is suspect, but without a detailed survey of soil behaviour actually under the stress of exceptionally high winds, it is very difficult to give a concise picture of the damage which may be occurring in different parts of India.

In soil erosion caused by water, it is the exceptionally severe storm spread over many hours, but with interspersed intervals of torrential downpour, which causes infinitely more damage than weeks or months of ordinary rain showers. So also in wind erosion, it is the sustained and exceptional storm which does the greatest damage, but here the phenomenon is of very high wind following weeks of drought, and possibly assisted by widespread ploughing operations or forest fires or excessive grazing, all of which leave powdery soil exposed to "dust devils" which carry it into the upper air.

Erosion by water and by wind is frequently found acting in turn on the same patch of ground but, roughly speaking, water erosion is a serious phenomenon on slopes of more than 3 per cent. whereas wind erosion is more prevalent on flat or slightly undulating surfaces. Nature sees to it that where water cannot punish man for his destructiveness and poor husbandry, the wind can do so. A land surface typical of wind erosion is carved out in hummocks of soil, the crest of each rise being built round some deep-rooted vestige of the previous plant cover. Round each of these centres the wind has picked away the exposed soil until quite deep channels have been formed with scallopped markings on the sandy surface reminiscent of wave-action ripple-markings on a sea beach. Such a landscape is well seen a few miles north of Campbellpur in the Attock District. In many places where a typical wind erosion landscape has not developed, however, wind erosion may, nevertheless, be serious, as can be judged from the way windborne sand and powdery grit accumulate behind *Euphorbia* and other live hedges. Mr. J. A. Wilson of the Forest Service recently quoted as examples the land along the Coimbatore—Bolanpatti and Coimbatore—Mettupalyam roads, and observant readers can doubtless add their own examples from their own countryside.

The loss from wind erosion is an even more insidious one than in water erosion, for the lightest particles in the soil are inevitably the ones you want to keep, the infinitely small grains of manurial material and partially leached salts. The factors which contribute to the severity of the wind erosion are bare earth surfaces of pulverised soil and a high wind with an unobstructed stretch for it to operate in. Eliminate any of these and the wind cannot collect a large load. First, then, keep the plant cover intact even if it is only an incomplete carpet of bunch grasses. Secondly, where ploughing is to be done, keep your fields under diversified crops in strips set at right angles to the prevailing wind. The actual velocity of the wind cannot, of course, be controlled, but by ridging the ploughed soil in plough land, soil drift can be greatly reduced. Thirdly, make full use of Nature's own prescription by growing shelter belts of trees and tall grasses.

Possibly the closest study of shelter-belts has been made in Russia, where recent planting under the second Five-Year Plan has amounted to 865,000 acres of shelter-belt, a truly gigantic scheme vying in scope with the American Great Plains Shelter-belt project. The efficiency of these shelter-belts across the wide and wind-exposed plains has been thoroughly tested and measured. They cause a marked increase in productivity in each field in a strip up to 20—25 times the height of the trees in the belt, even when the belt consists of a single line of trees. They not only reduce the extreme severity of the wind and stop it from transporting soil, but the temperature and aridity extremes are reduced so that the crop ripens more regularly. In snowy areas the moisture added to the ground by the deep and regular snowbeds in the rear of each belt is of the greatest value and contrasts markedly with unprotected land where the snow beats along in a blizzard and eventually leaves much of the ground frozen, uncovered and dry. Similar results are also reported from Canada and Hungary.

Soil is most in danger from wind when it is pulverised and broken down. When its natural aggregation into a crumb structure has been preserved and encouraged by good methods of husbandry, the danger is greatly reduced. When a large, flat, open area has been badly cultivated and starved of manure so that the

crumb structure has collapsed into a friable powder, the wind can produce chaotic damage in a very few days or even hours. The pulverised soil is lifted bodily from the surface of the fields and dumped around obstructions such as hedges, buildings, roads and railways where it is least welcome. The vagaries of such damage are often hard to understand, for the top few inches of fertile soil may be removed from one man's fields while another's field nearby is buried under a load of sterile sand. Soil thus lifted up is itself a potential destroyer, for it has a sandpapering effect upon any vegetation standing in its path, and in very severe dust-storms the vegetation may be stripped or browned off almost as if frost or hail had destroyed it.—*Current Science,* Vol. 9, No. 5, dated May, 1940.

INDIAN FORESTER

OCTOBER, 1940

A SHORT NOTE ON THE EXPORT ARRANGEMENTS FROM THE FORESTS IN SARDA VALLEY

By R. N. Brahmawar

The Sarda river before it enters the plains passes through a precipitous gorge 2½ miles in length. Above this gorge lie the high quality (I/II) valuable sal forests of Khaldhunga, Jariakhal and the major part of Purnagiri which were due for fellings in 1938-39. The high value of these forests has been well-known for 60-70 years but the difficulties and risks offered by this gorge with its vertical wall of rock had resulted in the general acceptance of the principle that the sal forests in this valley were unworkable.

The forests were however worked in 1923-24 in continuation of the Nepal Sal sleepers operations carried out by Mr. J. V. Collier, who had spent Rs. 1,04,905 on roads and Rs. 2,09,563 on construction of the tramway. But so much damage had been caused to the track in the following one rainy season that its reopening cost Rs. 22,000 and a further Rs. 1,000 for road repairs. By 1938-39 little trace was left of the tramway formation, the rails having been removed. The idea of again making a road or tramway could not be considered owing to exorbitant cost of construction. The estimated outturn was only 120,000 c. ft. so that some other cheap yet efficient means of export had to be devised.

Locality.—Reference has been made to the extremely difficult terrain. A description of the locality (*vide* Plate 40) through which timber was to be exported is given below:

I.—The hillside from Chuka to Khaldhunga is precipitous (2¾ miles).

II.—From Khaldhunga to Bhawanigad Parao the country is flat (4¾ miles).

III.—From Bhawānigad Parao slopes are extremely precipitous, the rocky strata being almost vertical; if a cart road were to be made

it would have to contour round $\frac{3}{4}$ mile costing several thousand rupees as also considerable risk to human life, the rocks being overhanging and unstable, but the distance in a straight line across the ravine is only 870 feet.

IV.—From Malla Sirkon for half a mile the country is easy to Sirkon Parao.

V.—From Sirkon Parao the gorge is extremely difficult for road making down to Thuligad, the strata often being again almost vertical sometimes even overhanging, and the cost of making a road would be prohibitive.

Fortunately from a point Talla Sirkon to Thuligad the river Sarda flows smooth; both above and below these points there are very nasty rapids that would make floating sal by boats impossible.

VI.—From Thuligad to Governor's Camp ($\frac{1}{2}$ mile) was a mass of big rocks and huge boulders.

VII.—Governor's Camp to Tanakpur, 7 miles of easy ground.

Mr. Champion, who was Divisional Forest Officer in 1923-24 and had carefully examined the terrain was of opinion that in Section III and part of Section V, the use of wire ropeways offered very considerable advantages. The idea however was subsequently given up for the following reasons:

1. No one had precise knowledge of ropeways.

2. The slope being only 5° down in Section AB [Fig. (1) Plate 41] and dead level in Section BC, the use of engine power was believed to be required and competent staff for this was not locally available.

3. Difficulty of transporting the engine to the site over a narrow hill footpath.

4. No spare parts would be available locally in case of breakdown.

5. No stock of ropeway material was available, hence it might not pay to purchase and erect ropeways for transport of the relatively small quantity of timber expected.

6. Complication of the ropeway system due to AB and BC being not in a straight line but at an angle of 155°.

7. No extra permanent staff was available, nor a gazetted Assistant, so that the direction of erection and running the ropeways

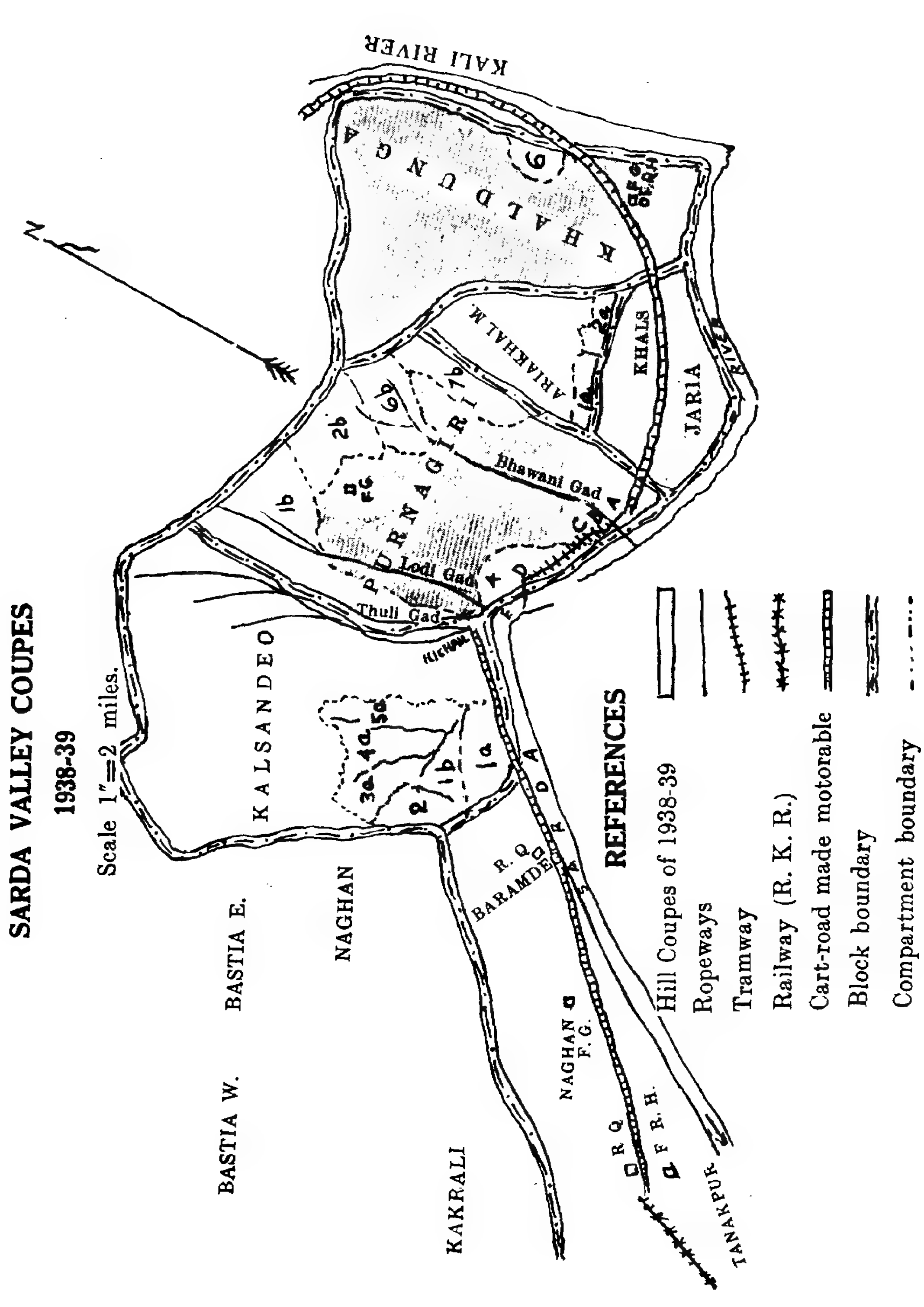

SARDA VALLEY COUPES
1938-39
Scale 1"=2 miles.
KALI RIVER
KHALDUNGA
PURNAGIRI
ARIAKHAL M.
KHALS
JARIA
RIVER
Bhawani Gad
Lodi Gad
Thuli Gad
KALSANDEO
SARDA
R. Q.
BARAMDEO
NAGHAN
BASTIA E.
BASTIA W.
KAKRALI
NAGHAN F. G.
R Q
F R. H.
TANAKPUR
REFERENCES
Hill Coupes of 1938-39
Ropeways
Tramway
Railway (R. K. R.)
Cart-road made motorable
Block boundary
Compartment boundary

Fig 1.

MAP SHOWING

ROPEWAY & TRAMWAY

Sarda Gorge Export

1938-39

Scale 6"—1 mile

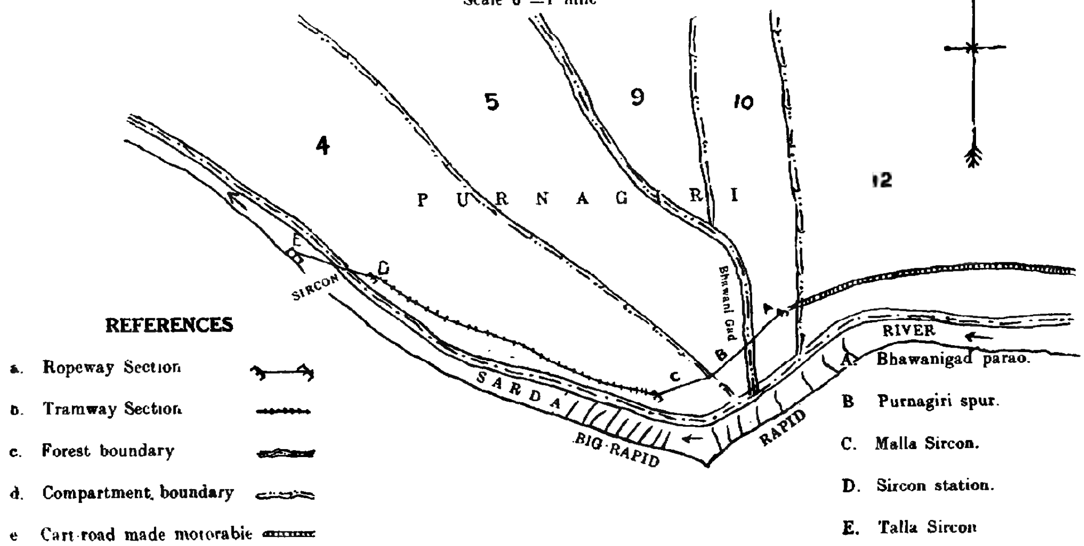
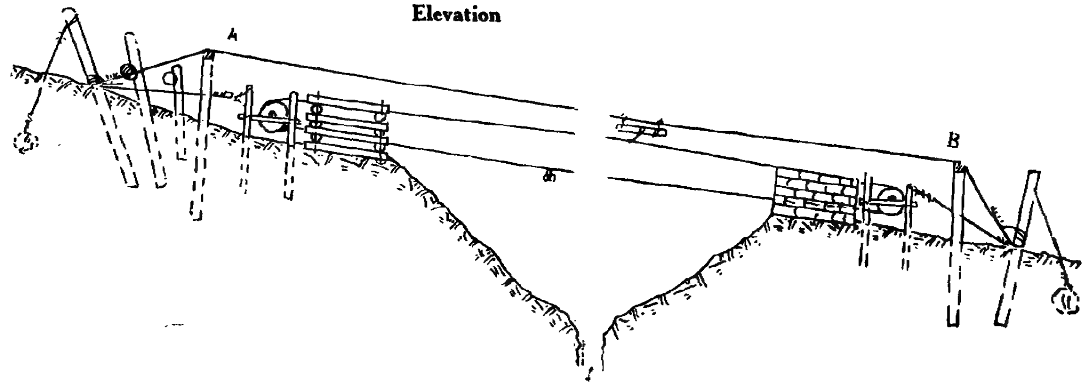


Fig 2.

A COMPLETE ROPEWAY SECTION

Plan

Elevation



would have to be done by the Divisional Officer in addition to his normal duties.

8. No funds were available for expenditure on this work.

The revised proposal therefore was to make export footpaths in place of the proposed ropeways.

At this stage while in charge of the North Kheri Division, the writer was informed that he would have to take over charge of Haldwani Division and therefore of the export arrangements, and he was asked to make suggestions. The question was thoroughly investigated. It was at once evident that the difficulties enumerated above were very real, but on the other hand it was also evident that there were very great advantages to contractors in the employment of mechanical means of transport:

(1) Labour was very scarce in the locality and it might not have been possible to get enough labour for carriage of 2,40,000 c. ft. (actual outturn); this might mean working the area for two seasons resulting in great loss to contractors and high cost to the department for repairing roads and paths for two years.

(2) If only export footpaths were made, the coolies could not carry heavy loads. Fine trees should then have to be converted into small sized timber only against valuable cart shafts and large beams and crossing sleepers. This consideration so appealed to the contractors that they applied for erection of ropeways, tramway and cart roads for which they voluntarily increased their bids by Rs. 8,435.

(3) Transport by ropeways and tramway on careful calculation proved to be much cheaper compared with coolie carriage.

(4) The difficulties of erection and running the ropeways could be overcome by forethought, application and hard work by the staff.

(5) The shortage of staff was counterbalanced by harder work by the staff available.

(6) Funds were not available but the contractors were keen and agreed to finance the scheme.

It was therefore decided, after mature consideration, to make the following export arrangements:

I. *Chuka to Khaldhunga* ($2\frac{3}{4}$ miles).

A 4-ft. path was made departmentally as only a small proportion of the timber of Haldwani Division was coming over this path. The contractors of the adjoining East Almora Division forests, however, made arrangements for transport of the largest size timber by converting this path into a motorable road at their own cost with the technical assistance of the Department.

II. *Khaldhunga to Bhawanigad* ($4\frac{3}{4}$ miles).

A motorable road was made departmentally.

No carts are available above the gorge. The previous idea of transporting carts and bullocks as in 1921-24 was given up as it would be most difficult to take such a large number of carts and bullocks to the spot and as no fodder was available locally the difficulties of daily transport of fodder would have been most bothersome and costly. These difficulties were solved by taking 10 motor lorries up to Sirkon, dismantling these into parts, transporting the parts by boats and footpath and reassembling at Bhawanigad Parao.

These 10 lorries working full time day and night could just cope with the timber transport to ropeway head. This showed how futile it would have been to employ carts.

III. *Bhawanigad Parao to Malla Sirkon station.*

Two sections of ropeway were erected with a common track support at B (*vide* Fig. I, Plate 41).

(*i*) From Bhawanigad Parao station A to Purnagiri spur station B, span 622 ft., and

(*ii*) Purnagiri spur to Malla Sirkon station C, span 248 ft.

The two sections bearing an angle of 155°, a special very simple labour-saving roller device was provided for unloading from the first and loading on to the second ropeway section.

IV. *Malla Sirkon to Sirkon station* ($\frac{1}{2}$ mile).

A 2-ft. gauge gravity tramway was erected. The rails and trucks were borrowed from the surplus material available at Lalkua. Offcuts were used for sleepers. The slope averaged 1 in 52 in favour of the load. The loaded trucks went down by gravity and empties were pushed up by manual labour.

V. *Sirkon station to Talka Sirkon* (span 541 ft.).

A section of gravity wire ropeway was erected (details under "ropeways"). This took the load down to the bank of river Sarda. A big *Parao* was made there for unloading of timber.

VI. *Talla Sirkon to Thuligad Parao* ($1\frac{1}{2}$ miles).

It has been mentioned that the river Sarda flows quite smoothly over this stretch of its course though both above and below it there are several rapids impossible to negotiate by boats or dugouts, hence the necessity of using motor road, ropeways and tramway above this section.

Advantage was taken of this smooth flow of the river and water transport of timber was arranged rather than make an extremely difficult and prohibitively costly road over the extremely precipitous hillside.

(*a*) No boats were available nor could the ordinary heavy local boats be taken up from the plains in view of the bad rapids. Dug-outs from *semal* felled locally were therefore prepared. Timber was not loaded on the boats as this would mean very little carrying capacity. Instead of this, timber was slung on both sides of the dugout on poles tied above and across the dugout, the timber being wholly immersed in water thereby reducing the dead weight on the dugout to the weight of the timber minus that of an equal volume of water (Plate 42, Fig. I). Thus loaded the dugout could carry from about 75 c. ft. to 175 c. ft. of timber per trip according to the size of the dugout.

As the actual outturn of timber proved to be 2,40,000 c. ft. against 1,20,000 c. ft. anticipated, due to very thorough conversion by contractors because of the better facilities of transport provided, the water transport by dugouts, satisfactory in itself, proved to be inadequate. More dugouts could not immediately be prepared, so other means of water transport had to be devised. Advantage was taken of the material available.

(*b*) *Chir* sleepers of some of the forest contractors were being floated past this stretch of the river. These were caught up and made into rafts consisting of 50 *chir* sleepers in the lower tier. By trial it was found that an upper tier of four sal alternating with one *chir* sleeper would float safely. Sal was, therefore, transported by such rafts as far as the supply of *chir* sleepers lasted.

(*c*) The above means proving inadequate, sal timber was floated with the help of floats made out of empty kerosene oil tins with their mouths soldered. These tins were locally available from the oil used for lighting up ropeway stations where, as explained later, work had to be continued during night.

A float unit consisted of six tins tied together with thin strips (dhajjis) of wood at the corners. These floats alternated with sal timber to form a raft. The local hill labour was initiated in this form of floating and though at first they could float down only small rafts, with practice, quite respectable rafts were made and manipulated by the local labour.

These three methods of floating completed the export.

VII. *Thuligad Parao to Governor's Camp* (½ mile).

Two *paraos* were made along the river bank for landing of timber after floating. Huge boulders 15 ft. to 20 ft. high had to be blasted, the smaller ones rolled down with the help of levers, to make a motorable road to the old camp site.

VIII. *Governor's Camp to Tanakpur* (7 miles).

A cart road 12ft. wide was made which was subsequently improved to permit motor traffic.

For sections VII and VIII carts were at first employed, but the shortage of carts together with large quantities of timber arriving at Thuligad proved too much for the carts. A fleet of motor lorries was, therefore, arranged to take the timber from Thuligad to Tanakpur.

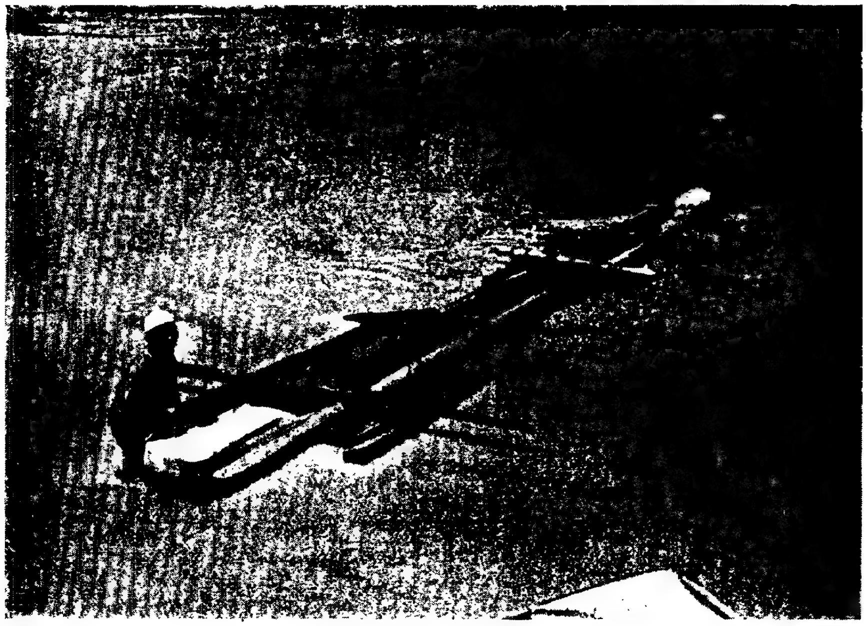
The export arrangements had to be thorough at each stage as accumulation of timber at any station would stop or slow down the export from the previous sections, there being only limited space for stacking timber.

Ropeways

Plate 41, fig. (2) shows the general plan of the ropeways.

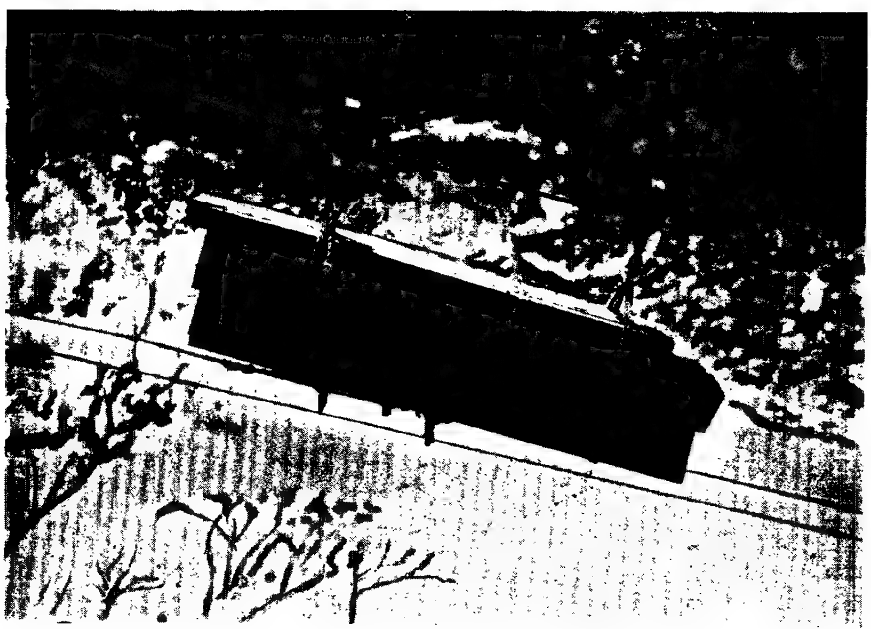
Several different ropeway systems were considered, the choice falling upon a single track rope and an endless hauling rope over rotating sheaves. The track rope consisted of 5/8″ diameter, Wright's ungalvanised (galvanised not being available). Best Patent, Basic grade steel wire rope, 6 × 7 construction, best main hemp core, Lang's Lay, breaking strain 13 tons. The check rope was

Fig 1.



No. 12. Floating sal timber slung on dugouts.

Fig 2.



No. 2. Load and carrier,

Fig 1.

No. 4. Load reaching near station B. Station A seen at a distance and a general view of the valley.

Fig 2.

No. 9. Station D showing load ready to leave for Station E.

6 × 19 construction for pliability and because small sheaves had to be used.

Tightening gear consisted of a simple wooden windlass $4\frac{1}{2}'$ girth by $2\frac{1}{4}'$ long with the projecting ends, trimmed down to $2'$ girth to act as axles rotating on nitches in two inclined posts buried 5 ft. in the ground and held by guy ropes which were tied to the anchor, a turn buckle being introduced to effect tightening when required. Sockets were chiselled into the windlass drum to take in levers to be worked by men.

Control sheaves were supported on two parallel horizontal wooden plates bolted on to four verticals buried 5 ft. in the ground. The supports were further held in position by guy ropes tied through a turn-buckle to the anchor post.

Sheaves were ordered from a reliable firm in Calcutta during the rains but due to a labour strike the order could not be executed. This caused considerable delay. Ultimately these had to be made locally at the small tramway workshop of the division at Lalkua under the writer's personal supervision from old discarded wheels, whilst for the sheave with brake band the grooved wheel was coupled to an old tramway wheel the tread of which was flattened on a lathe, the two wheels being fixed with a key on the same shaft. Old truck axle boxes were converted into bearing blocks, the bearing being cast, turned and polished locally. But for this local arrangement, the whole of the export work would have been held over to an indefinite date.

Track rope was supported on two vertical posts buried in the ground and provided with a cap. The fittings had to be very rigid and accurate. As very high speed had to be attained as explained later, the track and control ropes were kept accurately in the same vertical plane, (See plate 42, Fig. 2).

Section A B

In this section there was a slope of 5° only. With this very slight slope if the normal safe speed of 2 to 3 metres per second were kept, engine power would have been required with all the disadvantages of extra skilled staff, difficulty of transporting the engine, extra cost and the possibilities of a breakdown. To avoid all use

of engine power, great accuracy in fittings was ensured, the sag decreased by extra tightening of the track rope which was frequently oiled to keep its pliancy by means of a special oiling arrangement fitted on to the carrier. Ball bearings were fitted to the control sheaves and thorough and frequent oiling of these as also of the carriers was insisted upon. The full force of the momentum gained by the descending load down to the bottom of the sag was utilised resulting in a speed of 35—40 feet per second which carried the load up to its destination (See plate 43, Fig. 1).

Section B C

The points B and C were originally on a dead level. An artificial slope was created by decreasing the height of the track trestle at C and by lowering the formation level of the station and tramway head. This together with the measures adopted in section A B brought the load over 2/3rd of the total distance. A detachable handle was provided on the control sheave at C which worked by one man brought the load home.

Section D E was a simple gravity ropeway, (See plate 43, Fig. 2).

Schedule of rates

As it was not intended to earn large direct profit from the working of ropeways, the rates were kept down to the lowest minimum. For loading at A, transhipment of load at B, unloading at C, roping from A to C, unloading at C and reloading on the tramway, unloading from it at D and loading on the ropeway, roping to E and unloading there the charges for small timber up to 1.5 c. ft. was a ridiculously low rate of -/1/- per c. ft. increasing for the bigger sized timber to a maximum of -/3/3 per c. ft. for beams of 9 c. ft. No limit was fixed on the size of timber to be transported on ropeways and tramway.

The contractors gained very considerably from the low rates compared with coolie carriage (which also is limited to pieces of up to 2 c. ft.). These rates also induced them to convert inferior timber which otherwise they would not have taken out from these distant forests.

Capacity

Normally individual loads of 6 c. ft. each were sent on the rope but beams over 9 c. ft. each were also taken. The most

reasonable quantity that this form of ropeway could be expected to carry is 900 c. ft. per diem for a 10-hour working day. It has been explained that considerable delay was caused by non-receipt of sheaves. With 100 working days the capacity was therefore only 90,000 c. ft. during the season against 237,000 c. ft. ready for roping. To cope with this, the speed of roping was greatly increased by thorough organisation of labour. Ropeways and tramway were worked *night* and day all the twenty-four hours without stopping except occasionally for repairs and tightening of the track. It is to the great credit of the subordinate staff that working hard at all hours the daily roping capacity was increased upto 3,000 c. ft. It goes further to their credit that no accidents occurred in spite of abnormal speed of the load that had to be permitted. The accuracy of fittings and consistent strict supervision made it possible.

Financial results

The total quantity of timber exported by ropeways and tramway was 237,373 c. ft. which brought in a direct revenue of Rs. 20,481/- in freightage.

Expenditure		*Rs.*
(1)	Purchase of material	1,802
(2)	Railway freight and carriage to site ...	563
(3)	Construction of ropeways and tramway ...	1,589
(4)	Roping cost and labour on tramway and miscellaneous works	11,537
(5)	Dismantling and carriage back of material	395
(6)	Consumable articles and miscellaneous ...	1,142
	Total ...	17,028

The total profit by the venture is calculated as follows:

(1)	Net direct surplus over expenditure ...	3,453
(2)	Estimated (conservatively) resale value of material	612
(3)	Price increment of timber through export of large sizes being made possible—actually remitted by contractors to revenue	8,435
(4)	Freight foregone by charging very low rates compared with coolie carriage representing contractors' profits, not taken into account (Rs. 10,250/- estimated)	...
	Total profit excluding (4) ...	12,500

The profit including item (4) which a purely commercial undertaking should have made is Rs. 12,500 *plus* Rs. 10,250, *i.e.*, Rs. 22,750 which represents the return for the initiative and hard work of the staff working the scheme.

This is not all. It has been mentioned that but for the mechanical means of transport the export of timber could not have been completed within the season owing to the great scarcity of labour (in the later part of the season there was not enough labour for loading timber on motor trucks for which contractors had to pay high rates). Heavy loss would have resulted to contractors in having to work the area in two seasons by way of interest on capital and loss of sales. The department would also have had to incur heavy expenditure on repairs of roads and employment of staff for two years which was avoided.

Seldom has a Divisional Forest Officer had to organise in addition to his other duties such varied arrangements as transport by motor trucks in a stretch of the country unconnected by roads, initiation of three sections of ropeway presenting difficulties of power, a tramway at a place not connected by roads, floating by three different means each devised especially for the locality, and final export by motor buses. Failure at any stage would mean disorganisation of the whole transport arrangements, and it is greatly to the credit of the staff to have ensured success that this export work was brought to a successful conclusion.

TRANSLATION OF TECHNICAL FORESTRY TERMS IN INDIAN LANGUAGES

BY K. P. SAGREIYA, I. F. S.

Several provinces and states now have Forest Schools where instructions are given through the medium of the local language. But so far little attention seems to have been paid to finding suitable equivalents for technical forestry terms and even less to writing text books in Indian languages. My experience as an examiner of the *Hindí Forest School at Balaghat has been that the language

* All Indian words throughout this article have been transcribed in the suggested modified Roman script.—K. P. S.

used by the students (and presumably also by the Instructors, who are Rangers detached from the regular line from time to time) is a curious jargon, a conglomerate of English, Hindí, Urdú and Maráṭhí, with little regard to syntax, grammar or correctness of expression. This is obviously due to the fact that standard equivalents do not exist. Practically no efforts have so far been made to remove this serious drawback in our educational system. That this subject calls for immediate attention cannot be gainsaid and it is the purport of this note to deal in some details with the nature and extent of the problem and to suggest how it may be tackled.

The work of evolving suitable technical forestry terms in the regional* languages will be no more difficult than what must have confronted those who for the first time translated terms in mathematics, physics, chemistry, etc., which subjects are now being successfully taught in Indian languages not only in elementary schools but even in colleges up to the higest degree, and in which suitable text books have been written. Actually, it should prove a comparatively easier task, because suitable equivalents for terms common to sciences allied to forestry already exist, and the system followed for translating has been already worked out in detail. In this connection the work done by the Usmánia University (Hyderabad), the Vishvabháratí (Shántiniketan), the Gurukul Mahávidyálaya (Kángri), the Hindí Sáhitya Sammelan (Benares), and to a greater or lesser extent by other Universities and Institutions, *e.g.*, the Journal "Vijñan" in Hindí from Allahabad, deserve special mention, particularly the attempt to compile a scientific dictionary by the Vishvabháratí. Any organisation set up to translate forestry terms will do well to refer to the work done by these institutions, if for nothing else, at least to avoid duplication of terms in any particular regional language, which can quite easily happen, as for instance 'earthquake' has been variously translated as bhúchál, dharṇíkamp, bhúḍol, etc., in Hindí.

The first question that will confront the translators will be to decide whether the rendering should be in the current regional language—if suitable words are available—or to derive equivalents

* This would be a more suitable term than "local" for the word "vernacular" used till recently and now a taboo, because of its etymological meaning which has been considered objectionable.

directly from the classical languages of the country, viz., Samskṛt, Persian and Arabic, or to adopt the English words *per se* or the corresponding scientific equivalents in Latin, Greek, etc., as the case may be. Use of prevalent words of the local language (be they derived from Indian classical languages or adapted from English) has the merit of simplicity and should naturally receive preference, where mere description is concerned and absolute scientific accuracy is only a secondary consideration. As against this, adoption of words directly derived from the classical Indian languages (and if need be also the European languages), will have the advantage of being adapted for a considerably wider tract. Indeed, this may eventually prove to be far more desirable from the scientific point of view. Direct derivatives from Samskṛt will be easily understood by all who have learnt Hindí, Bangálí, Maráṭhí, Gujarátí, Uriyá, and even the South Indian languages, such as Telagu, Támil, or Malayálam, etc., which, as the broadcast in these languages from Delhi shows, contain a large proportion of Samskṛt words. Similarly all those who have learnt Urdú will readily understand words derived from Persian or Arabic. This is what actually happened on the continent of Europe where scientific words have been mostly derived from the classical languages, Greek, Latin, etc. That is why those who know English can with little trouble easily follow scientific literature in other European languages.

In enumerating the principal regional languages of India I have deliberately omitted to mention "Hindustání." This is the name coined for the spoken language of Northern India which with its extremely limited vocabulary—I refer to the language of the masses —bereft of all Samskṛt and Perso-Arabic words used only by the Intelligentsia, is the common meeting ground between Hindí and Urdú of to-day. The verb forms of Hindustání are mostly derived from Samskṛt. Other parts of speech are corruptions of words from Samskṛt, Persian, Arabic and other languages with which Hindustání has come in contact. To enrich this conglomerate of a language and thus make it suitable for modern requirements recourse had had to be taken to the vocabulary of the classical Indian languages or to adopting foreign words *per se*. In the meantime, unfortunately for the country, the communal virus entered into the

body politic. The result has been that Hindustání enriched by the inclusion of Saṁskṛt words became Hindí, and replenished with Perso-Arabic words it became Urdú. Any one familiar with the modern literature of these languages can see that now they are two entirely different languages and the gulf between them is widening as the vocabulary increases. For every new word derived by the paṇḍits from Saṁskṛt a corresponding word is always coined from Persian or Arabic by the maulvís, even though a perfectly good and serviceable spoken word is available. But even to-day devoid of these artificially introduced words the desideratum is still Hindustání, the language developed by the unsophisticated masses.

As has been pointed out above, the spoken language (Hindustání) has a very limited vocabulary, which is quite inadequate for literary or scientific purposes and that the adaptation of direct derivatives from classical languages, which have a rich vocabulary, has the merit that such words can be understood over a much wider tract. It is therefore suggested that in translating forestry technical terms, for every English word two synonyms should be standardised, one derived from Saṁskṛt and the other from Perso-Arabic, unless a current and well-understood word is readily available. Curious mixtures as seen in scientific names such as *Madhuca latifolia, Tetraceras quadricornis, Azadirachta indica* may be all right so far as proper names are concerned but when translating common or abstract nouns and other parts of speech one or the other language should be exclusively used.

Next there is the question of the script. Not only there is a multiplicity of scripts in our country (Urdú, Devanágarí, Bálbodh, Gujarátí, Gurmukhí, Bangálí, Uriyá, Telagu, Támil, Malayálam, etc.) but to a greater or lesser extent every one of these is unsuited for quick and cheap printing; and what is even more important for our purpose, each is understood over a limited zone and is almost totally unintelligible outside it. On the other hand, it is common knowledge that if any particular language, say for instance Bangálí, were to be written in another script, say Devanágarí, with which Hindí speaking people are familiar, most of it would be easily understood by them. This is true of most Indian languages to a greater or lesser extent. It is thus obvious that a common script, well-suited for printing will be a great boon to the country.

For various, recorded and unrecorded*, reasons adoption of the Roman script has not found favour in India. The claims of the International phonetic script also do not seem to have been considered. In the circumstances, until a suitable common script for the entire country is evolved it is suggested that the glossary of technical forestry terms, when ready, should be printed in a modified Roman script using suitable diacritical marks to express all Indian sounds without ambiguity, as is done in European books on these languages. One such system for expressing modern Hindí sounds is indicated at the end of this note.

It will be seen that as aganist over 200 different types at present used to correctly print Hindí in the Devanágarí script (because half-consonants, conjunct-consonants and vowels-in-combination-with-consonants change their form altogether, and besides linear composing as is the case with the Roman script in Hindí, parts have also to be inserted above and below the line) only 37 symbols will be needed.

Lastly, there is the question of the arrangement that should be made for preparing the required glossary. The most suitable body which could take up this work will be the All-India Silvicultural Conference. It could discuss this subject at its next session and then appoint a committee consisting of forest officers familiar with the various Indian and classical languages as also expert philologists and translators, for the preparation and publication of a glossary.

It is hoped that readers interested in this subject will express their views in the pages of the Forester so that enough material is availabe to take up this subject for discussion at the next Silvicultural Conference.

In this connection it may interest readers to know that some work on the subject has already been done in the Punjab where a committee of certain forest officers has been formed to prepare a glossary of technical forestry terms in Urdú, (*Vide* item 10 of the Punjab Forest Conference, 1939), which is taking the help of the Usmania University.

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* For instance, at the last meeting of the National Planning Committee, while considering the report of the General Education Sub-Committee, Dr. Megh Nad Saha, F.R.S., proposed that the Latin script should be adopted in India in place of other scripts. After some discussion Dr. Radha Kamal Mukerjee and Dr. C. A. Mehta also supported the proposal, but the other members felt (reasons not available to the public) that it was not feasible, at any rate under the present circumstances. *Vide* N.P. Committee's Handbook No. 3, July, 1940.

CORRECT TRANSCRIPTION OF ALL HINDĪ SOUNDS IN MODIFIED ROMAN SCRIPT.

The scheme adopted by the International Congress of Orientalists at Athens in 1912 and since then generally acknowledged to be the only rational and satisfactory one for correctly transliterating Saṁskṛt is as follows:

VOWELS

अ	आ	इ	ई	उ	ऊ	a	ā	i	ī	u	ū
ऋ	ॠ	ए	ओ	अं	अः	ṛ	ṝ	e	o	ṁ	ḥ

DIPHTHONGS

ऐ	औ	ai	ou*

CONSONANTS

क्	ख्	ग्	घ्	ङ्	k	kh	g	gh	ṅ
च्	छ्	ज्	झ्	ञ्	c	ch	j	jh	ñ
ट्	ठ्	ड्	ढ्	ण्	ṭ	ṭh	ḍ	ḍh	ṇ
त्	थ्	द्	ध्	न्	t	th	d	dh	n
प्	फ्	ब्	भ्	म्	p	ph	b	bh	m
य्	र्	ल्	व्		y	r	l	v	
श्	ष्	स्	ह्		s'	ṣ	s	h	

In this scheme the inconsistency, irregularity and redundancy of English spelling are ruled out: f, q, w, x and z are not called to use; one fixed value is given to each letter. Hence a, e, i and g always represent अ, ए, इ and ग् respectively and never ए, इ, ऐ and ज् or other values which they have in English; t and d are always used for त् and द् only. One *tialde*, one *accent*, four *macrons* and ten *dots* (2 above, 8 below) are used to represent adequately and correctly all Saṁskṛt letters. *The letter c alone represents* च्. Since the natural function of h will be to make the अघोष (aghosa) घोष (ghosa)† namely, kh, ch, ṭh, th, ph, gh, jh, ḍh, dh and bh, it would be an anomaly for a scientific scheme to use it in combination like ch and sh for च् and ष् values; hence ch here is छ् and sh स्ह् (which never occurs in Saṁskṛt). The

* Personally I would prefer *au* as being phonetically more correct.—*K. P. S.*
† Aspirate.

vowel ऋ is represented by ṛ because ri, legitimate for रि only, is out of place and the singular ṛi is an altogether objectionable distortion.

The *tialde* over n represents ञ् (ñ). *Accent* mark over s gives श् (s'); *dots* above m and n give अनुस्वार (anusvāra) "ं" (ṁ) and ङ् (ṅ) respectively. Dots below h and r give विसर्ग (visarga) " : " (ḥ) and ऋ (ṛ) respectively. *Dots* below s, n, t and d give their corresponding cerebrals ष्, ण्, ट् and ड् (ṣ, ṇ, ṭ and ḍ); and *macrons* over a, i, u and ṛ give ā, ī, ū and ṝ that is आ, ई, ऊ and ॠ respectively. *Macrons* are not used to lengthen the quality of e and o, because these letters always have the long quality in Saṁskṛt.

Suggested modifications of the Saṁskṛt sounds depicted above, ङ् and ञ् are always followed by gutteral and palatal consonants respectively, and never by a vowel, either in Saṁskṛt or in Hindí and although one way of writing them is to put an *anusvāra* over the preceding syllable, e. g., किंकर or चंचल in English transcription mere n could always be used for both ङ् and ञ् without causing any ambiguity. Similarly although phonetically s and h in combination (स्ह्) is not श् the common practice of depicting its sound by sh could be adopted and the accent mark (') altogether done away with.

Besides these saṁskṛt sounds, there are in Hindí the following sounds ड़ and ढ़ for instance in पेड़ and चढ़ाव and the Perso-Arabic sounds represented by क़्, ख़्, ग़्, ज़् and फ़्. For these the following symbols could be used without ambiguity. ṛ, ṛh, q, qh, x, z and f respectively.*

Thus the different symbols used will be :

a, ā, i, ī, u, ū, ṛ, ṝ, e, o, ṁ, ḥ,

k, g, c, j, ṭ, ḍ, t, d, p, b,

n, ṇ, m, y, r, l, v, s, ṣ, h,

ṛ, q, x, z, and f;

* The only sound that is thus left out is the semi-nasal found in words such as पाँच, रँग, गेहूँ, etc.—compare French *ensemencement*, English *Singer* (-ng-) as opposed to *finger* (-ngg-). A suitable symbol could be easily devised for this also.

that is 37 in all, by which all Hindí sounds could be correctly transcribed in the modified Roman script without any ambiguity.

The above script could be adapted for *typing* by using digraphs, *i. e.* by placing say, a colon (:) for dots below the letters, a double *accent* (″) for dots above the letters and a single *accent* (′) for the *macron*, after the corresponding Roman letter symbol, thus—

PRINTSCRIPT	TYPESCRIPT
ṛ ḥ ṭ ḍ ṇ ṣ	r: h: t: d: n: s:
ṁ ṙ	m″ r″
ā ī ū	a′ i′ u′

and a trigraph, namely, r:′ for the extremely rare vowel ṝ.

I quote a passage in the proposed typescript as an exercise for the interested reader. In this example the semi-nasal has been transcribed as an asterisk after the syllable, and the vowel 'a' has been omitted wherever, although written in Devanágari, it is not pronounced. For instance, strictly speaking **करना** should be transcribed as karana′. Actually it is pronounced as karna′ and has therefore been so transcribed; similarly, although always written, the ultimate 'a' is silent and in transcription it has been omitted to avoid confusion (though in technical terms it will have to be written because it is fully pronounced in Saṁskṛt). The reader will see that the passage given below contains all the Hindí letter sounds.

हिन्दुस्तान में अब ऐसे कई जंगल स्कूल खुल गये हैं जहां शिक्षा स्थानीय भाषा ही में दी जाती है। लेकिन मुक़ामी ज़बान में लिखी किताबें नहीं के बराबर ही हैं। इसका ख़ास सबब अंग्रेज़ी अलफ़ाज़ का हिन्दुस्तनी बोलियों में तर्जुमा यानी अनुवाद करने की कठिनाई है। इस कमी को दूर करना बड़ा ज़रुरी है। इसी की चर्चा मैंने यहां की है, यानी पारिभाषिक शब्दों का कोष कैसे तय्यार किया जाय और वह किस तरह छापा जाय ताकि सारे हिन्दुस्तान की स्कूलों में काम में लाया जा सके।

सबसे अच्छा तो यह हो कि प्रत्येक अंग्रेज़ी शब्द के लिये दो समानार्थी शब्द गढ़े जायँ एक संस्कृत से निकला हुआ और दूसरा

फ़ारसी या अरबी से। दोनों एक ऐसी लिपि में छापे जावें जिसे हर कोई पढ़ सके, जिसे छापने या टाइप करने में ज्यादः दिक़्क़त न हो और जिसमें हिज्जे ऐसी हो कि उच्चारण में ग़लती न हो सके, जैसी 'डर' और 'दर' को रोमन लिपि में लिखने पर हो सकती है।

Hindustán me* ab aise kaí jangal skúl khul gaye hai* jahá* shiks: á stháníya bhás: á hí me* dí játí hai. Lekin muqámí zabán me* likhí kitábe* nahí* ke barábar hí hai*. Iská qhás sabab A*grezí alfáz ka Hindustání bolíyo* me* tarjumá yání anuváda karne kí kat: hináyí hai. Is kamí ko dúr karná bar"á zarúrí hai. Isí kí carcá mai*ne yahá* kí hai, yání páribhás: ik shabdoṅ* ká kos: kaise tayyár kiyá jáy aur vah kis tarah chápá jáy táki sáre Hindustán kí skúloṅ* me* kám me* láyá já sake.

Sabse acchá to yah ho ki pratyek A*grezi shabd ke liye do samánárthí shabd gar"he jáy*, ek Sam"skr: t se niklá huá aur dúsrá Fársí yá Arabí se. Dono* ek aisí lipi me* chápe jáve* jise har koí par"h sake, jise chápne yá t: áip karne me* zyádah: diqqat na ho aur jisme hijje aisí ho ki uccáran: a me* xalati na ho sake, jaisí d: ar aur dar ko Roman lipi me* likne par ho saktí hai.

THE PROPAGATION OF BOMBAX MALABARICUM FROM ROOT-SECTIONS

By S. P. Sahi,

Forest Ranger, Silvicultural Branch, Forest Research Institute, Dehra Dun.

Summary.—Small sections, only 1 to 3 inches long, of the roots of one-year-old seedlings of **Bombax malabaricum** when planted in moist sand produced roots and shoots and grew vigorously. The bottom portion grew less vigorously than the central or top sections.

In nursery beds and elsewhere in the Experimental Garden wherever *Bombax* plants were dug out with a view to getting rid of them, it was noticed that new shoots occupied the position of the parent plants although the latter were dug out more than 18″ deep. The new shoots came up rapidly and grew vigorously. The origin of these new plants is the slender root apex left underground after the major portion of the root had been dug out. This led to the following investigation:

PROPAGATION OF BOMBAX MALABARICUM FROM ROOT PIECES

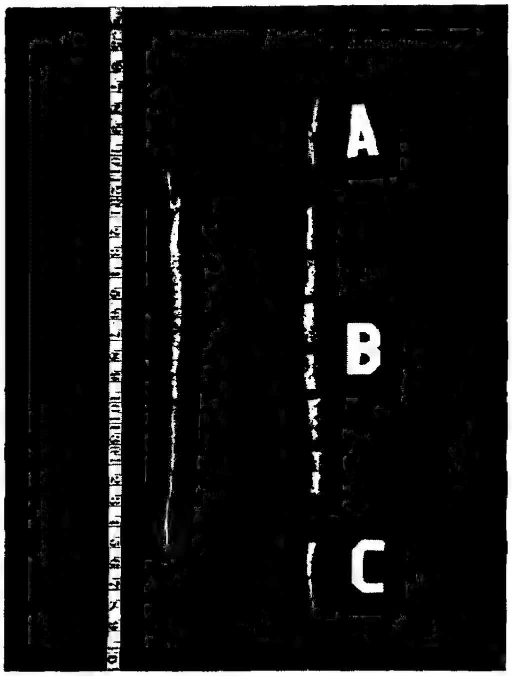

Fig 1. Shows the three types of root-pieces cut from a "stump."

Fig 2. Two months' development of an "A" piece.

Fig 3. Two months' development of "B" pieces planted accidentally upside down.

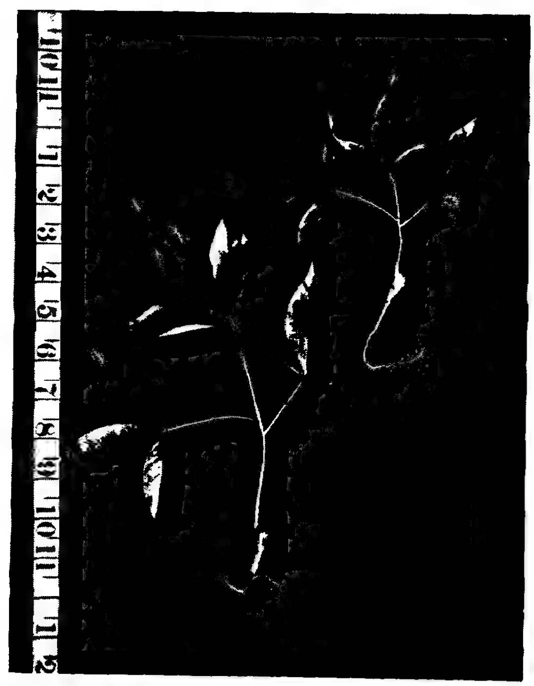

Fig 4. Two months' development of "C" pieces. Less vigorous than "A" or "B."

In July 1939 an experiment was conducted on a laboratory scale. Roots of 1-year-old nursery plants were used for the purpose. These roots were cut into sections 1″—3″ long with a sharp knife. The sections or pieces of roots were classified into the following 3 classes (Fig. 1, plate 44):

(A) The uppermost root-section with 1″ shoot above the collar.

(B) Intermediate root-sections.

(C) The remaining root apex.

At the time of planting the above root sections the very few rootlets that were present on them were shaved off.

Coarse river sand was chosen as the medium for planting the root-sections, simply for the reason that sand gives the least resistance in the operation of uprooting the plants for subsequent study of root development.

Hand watering was given soon after planting and this was continued on alternate days for the first month and then at longer intervals. Watering would not have been necessary if planting had been done in the open where they would get monsoon showers.

Results.—4 days after the planting the root sections began to sprout—lot (A) were the first to appear. Two months after planting quite a number of them had developed into vigorous plants and on counting them the development percentage and their corresponding heights were as follows:

	Plant %.	*Average height.*
(A)	90	7″
(B)	92	7″
(C)	50	$2\frac{1}{2}$″

After two months' growth some of the plants of all the above three categories were dug out for examining the root development. Plants from (A) and (B) sections had developed sturdy and reliable root systems. Plants from (C) sections were weak from the very start but had also developed lateral rootlets. One or two typical plants of each lot were selected and photographed to show the effect. Some of the (B) root-sections which were inadvertantly planted upside down also grew vigorously—the roots developed from the top and went downwards while the shoots started from below and travelled upwards (Fig. 3, plate 44).

In October the plants were again counted. They were all healthy and growing promisingly. The survival percentage and their maximum and average heights are shown below:

	Survival %	Heights Max	Heights Average
(A)	90	12″	8″
(B)	92	12″	8″
(C)	50	6″	3″

Roots were again dug out in November at the time of exhibiting them to the Silvicultural Conference. They showed further developments—active and growing.

Conclusions.—This experiment demonstrates that root sections of *Bambax malabaricum* cut from one-year-old nursery seedlings develop both roots and shoots. No difference in vigour was noticed between sections containing shoot and those containing root only in the vigour of development, excepting the thin root-tip sections (C) which gave poorer results. When sections were planted upside down inadvertently, the roots came from the top and turned downwards and the shoot from the bottom turned upwards.

Bombax malabaricum is generally raised by direct sowing when conditions are favourable, as this is the cheapest method. Stump-planting is more reliable, however, under adverse conditions. The above experiments suggest the possibility of using root-sections for raising *Bombax* when nursery stock for stumping is short, though whether these root-sections will give as good results under adverse conditions as direct sowings still requires to be tested.

WHEN WILL THAT DAY COME?

(A Soliloquy in Forestry)

BY S. RANGASWAMI.

1st *March*, 1939. *Aiyur camp.*—What beautiful forest scenery with the white spot of a Forest Rest House and a green meadow in front, surrounded by steep slopes which are crowned with almost impenetrable forests. Along this flat, runs bordered with *lantana*, bamboos, sandal and other trees, the loop road to Nyamasandiram

Agraharam experimental areas winding through the gently rising hills. Though hot and sultry, passing slowly on a motor cycle with hot air blowing in front, is indeed a joy ride. The variegated sparkling colours of *lantana*, as though it were the scintillations from a thousand rubies, have disappeared at the approach of the hot weather. Many of the deciduous trees which have shed their leaves are showing their heads like sign-posts as a warning of the approaching danger. Beautiful sandal trees already touched by the death hand of 'Spike', as if to keep company with the other trees have also raised their bare heads above the pest of *lantana*.

2nd March, 1939.—A patch of white cloud is noticed from the Samayeri hill slope opposite to the Bungalow.

The Forest Guards and others camping at Aiyur rush to the spot and find the grim reality of a forest fire. In a minute a flame is seen and in another minute a continuous line of lights, both big and small, not only in this Reserve but in several other adjoining Reserves, as if it were bonfires lit on several hills for the celebration of "Jubilee day," set alight by irresponsible villagers or graziers, perhaps to get a handful of grass or to wreak vengeance upon the forest subordinates against whom they had a grudge, or perhaps to cover their own illicit dealings. Whatever may be the cause, the fire is a reality, spreading on all sides consuming everything with its thousands tongues of flame. The subordinates vainly exhaust themselves in trying to put them out. It is a vain attempt; because, who can go into the impenetrable *lantana* except to stand by and gaze at the havoc caused? The fire dies out naturally having burnt everything that can be burnt. What a havoc the fires have caused!

The rigid protection of many years is gone. All trees useful for the ryots have been destroyed; the forest treasury of sandalwood has been badly looted; valuable sylvicultural experiments are snatched away. Thousands of birds and beasts have been rendered homeless apart from a huge number that have perished in the flames. The soil has deteriorated and a set-back has been given to natural regeneration by the destruction of seeds and seedlings. The forest floor is rendered bare by the destruction of its valuable cover. The water level is pushed down deeper and all sources of

springs and water-holes dry up. Thus a colossal damage—an irretrievable damage—has been caused.

It is difficult to estimate the value of the damage in money, but as a conservative estimate, it is calculated that, allowing for the stock of sandalwood and fuel species destroyed, grazing lost, deterioration of the soil and the cost of replacement of the crop, the bill for damages will come to not less than Rs. 600 per acre. In the fires described above, over 4,000 acres were burnt giving a total estimate of damage done of about Rs. 24,00,000!!

What is the reason?—illiteracy and ignorance are the root causes. People living in and near the forests neither understand the potential value of the jungle nor the duties of the Forest Guards in protecting them; and frequently bear some malice or grudge against them. People living in the vicinity of the Forests are ignorant of the cardinal fact that whereas a forest can be destroyed in a few minutes by fire, it will take years of laborious and expensive effort to rehabilitate it; they are ignorant of the fact that for the paltry immediate benefit they are likely to secure by incendiarism, which in any case does not amount to more than a few months' good grazing for their cattle, they are destroying all the advantages which are secured in perpetuity to posterity by the existence of good Forest growth in the vicinity of their villages. Such benefits are too numerous to enumerate; but the even flow of water in streams and rivers, the perennial supply of water in wells, the perpetual supply of small timber for agricultural purposes and house building, thorns for fencing and green manure for wet fields and, finally, the moderating climatic influence of Forests are among the many benefits which can be directly attributed to Forests. Not until the grazier and the villager are made to understand and appreciate the fact that Departmental restrictions on the free enjoyment of State Forests are imposed solely in the interests of posterity, will that co-operation between the ryot and the Forest subordinate, so essential for the prosperity of Forestry and its handmaiden Agriculture, be forthcoming and the danger from incendiary fires be lessened.

WHEN WILL THAT DAY COME?

ON CERTAIN UNKNOWN PLANTS FROM AFGHANISTAN

By S. A. Akhtar, Professor of Biology,
Faculty of Medicine, Kabul

During the last few years I have been able to make a collection of plants from Kabul and its environs. While working on the specimens (from Ranunculaceæ to Ampelidaceæ), I came across four plants which appear to be new to science. These are described herewith. Type-specimens and other specimens belonging to this part of the collection, have been deposited in the Herbarium of the Forest Research Institute, Dehra Dun. I intend to publish a report on these specimens at some future date. I am greatly indebted to the President of the Institute for kindly allowing me to use the Library and the Herbarium and also to Dr. N. L. Bor, Botanist, for his help and confirmation of the new species.

Acanthophyllum (Macrodonta) *montanum* Akhtar, spec. nov.; *Acanthophylli grandiflori* Stocks, affine sed ab eo floribus 4-bracteatis, tubo calycis 5-dentato, lobis calycis binerviis recedit.

Finely pubescent, spiny-leaved perennial shrub. *Branches* dense with nodes and internodes. *Leaves* spreading, spinose-tipped, flat above, convex below, 2 cm. long. *Flowers* terminal and solitary, purple, 12 mm. in diameter, subsessile, with 4 bracts at the base; bracts coloured, lanceolate, spreading when dry; tips spinose. *Calyx* tubular, 6 mm. long, 10-nerved; lobes coloured, margined, lanceolate; tips spinose, spreading when dry, 2 mm. long. *Petals* 5, spathulate, longer than the calyx, 8 mm. long. *Stamens* 10, anthers big, filaments long. *Styles* 2, free; gynophore short. *Ovary* 1-celled, 4-ovuled. *Capsule* sub-indehiscent; seeds ovoid-reniform, hilum lateral; embryo peripheral.

Growing wild in the crevices of rocks on hillsides of Tungi-a-Syedan. Flowering in June. Typus in Herb. Dehra Dun, No. 85863.

Gypsophila erinacea Boiss. var. *acuminate* Akhtar var. nov.; a forma typica statura minore, petalis acuminatis differt.

Smaller than *G. erinacea* typica in size, in length of leaves, calyx and petals. *Petals* distinctly acuminate. *Leaves* 12 mm. long, calyx 4 mm. and petals 4.5 mm. long. Typus in Herb. Dehra Dun, No. 85866.

Growing wild on hillsides in Tung-a-Gharoo. Flowering in June.

Gypsophila (Pseudacanthophyllum) *scapiflora* Akhtar, spec. nov; *Gypsophilæ acerosae* Boiss. affinis sed ab ea foliis spinosis, supra planis subtus convexis, erecto-patentibus, bracteis lanceolatis, spinosis distinguitur.

A much branched, pubescent, perennial herb. *Branches* ascending and spreading. *Leaves* spreading below and somewhat erect above, 2-nerved at the base, tips spinose, 13 mm. long. *Inflorescence* capitate, peduncle 9 cm. long; bracts yellow, triangular, elongate, lanceolate with appressed pubescence, 1-ribbed, tips spinose, light orange-colour. *Short pedicel* and calyx glandular-pubescent; calyx unarmed, turbinate, 5-ribbed, green, 3.5 mm. long, robes 5, linear 1.5 mm. long. *Petals* 5, light rose-colour, 7 mm. long, spathulate, acute, attenuate below. *Stamens* 10, filaments long. *Styles* 2, ovary 12-ovuled, radicle prominent. *Capsule* 4-valved.

Growing wild on hillsides in Tung-a-Gharoo. Flowering in June. Typus in Herb. Dehra Dun, No. 85864.

Haplophyllum afghanicum Akhtar, spec. nov.; *Haplophylli cappadocici* Stocks affine sed ab eo petalis pilosis, ovario glabro facile distinguendum.

An annual herb, glandular pubescent, about 16 cm. high. *Branches* from the base, wiry, flexuous, spreading and ascending. *Leaves* entire, subpetiolate, ovate-oblong, acute, tips slightly curved, with pellucid glands, 20 mm. long and 7 mm. wide. *Cauline* leaves 2-3-partite. *Flowers* greenish-yellow, shortly pedicelled, 9 mm. in diameter. *Calyx* pubescent, 5-lobed, lobes small, triangular. *Petals* 5, distinctly clawed, glandular-pubescent outside, blade acute, with a median green streak. *Stamens* 10, filaments dilating below and uniting to form a small tube surrounding the ovary, pilose inside. *Style* long and bent at the base. *Ovary* 5-lobed, horned, glandular, glabrous. *Cells* 2-ovuled; ovules collateral. *Capsule* dehiscent. Typus in Herb. Dehra Dun, No. 85867.

Growing wild on the left side of the road going out of the Bagh-a-Balla building and at the base of the same hillock, also seen growing wild behind Qilla-a-Fattooh, generally in dry places Flowering in June.

REVIEWS AND ABSTRACTS

FILTH FLIES, THE FAUNA OF BRITISH INDIA, DIPTERA, VI, CALLIPHORIDAE

BY R. SENIOR WHITE, DAPHNE AUBERTIN AND JOHN SMART.

PP. L—XIII, 1—288, *figs.* 152, 1 *map.*

Price 18 *shillings.* 1940.

Soon after the outbreak of war it was decided at the India Office to discontinue the publication of the *Fauna of British India*, which had started in 1888 and provided for zoologists in India many valuable monographs on animal life from protozoa to monkeys. About the same time it was officially and publicly announced in Delhi that well-planned long-term pure research should not be considered a luxury marked for elimination the moment war breaks out. That early period of the war was characterised by conflicting ideals in many fields of endeavour.

The latest volume of the *Fauna* that has reached India was published on March 28th, 1940; perhaps it is also the last volume, we don't know. Its life-history so far has been unusually eventful and it could fittingly complete its destiny as the last of its order. The volume on the Calliphoridæ was written in part by three authors and

in its embryonic stage had a fourth author, W. S. Patton, but only two authors remained to foster its final stage. Nevertheless the result is a monograph of 214 species of Oriental flies which live disgusting lives, some feeding in excrement and decaying flesh, or causing evil-looking and foul-smelling ulcerous myiasis in human bodies, others, better known as blowflies or bluebottles, buzzing over sweets and meats in bazaars.

The component parts of the present family Calliphoridæ have in the past been variously attached to other families, but the present grouping gives them equal rank with the house flies, the bot flies and the parasitic flies. Medical aspects of the disease-carriers and myiasis-producers have been well studied but for the rest and for many common everyday flies surprisingly little is known of life-histories. Because this group has been relatively neglected compared with groups more attractive to collectors, the fauna listed in this book takes cognizance of the species of the entire Oriental region and not only of India, Burma and Ceylon as is usual.

C. F. C. B.

EXTRACTS

THE POSSIBILITY OF CLOSE CO-OPERATION FOR MUTUAL BENEFIT BETWEEN AGRICULTURE AND FORESTRY IN THE AMERICAN TROPICS

BY L. R. HOLDRIDGE, ASSOCIATE FORESTER

The story of the reduction of Puerto Rican forests to their present remnants before the onslaught of such destructive weapons of an increasing population as the uncontrolled axe and shifting agriculture is an account which is being repeated in many other parts of tropical America or which will come to be true unless proper steps are taken to protect existing forest resources by uniting the various forces in action into an appropriate programme of

land use. Protection alone without utilisation would be purposeless and protection at the expense of growing agricultural needs of a nation would be misdirected purpose. The best solution should be found in due consideration by and for each other of the two main land uses—agriculture and forestry. Each country presents a distinct problem comprising many factors such as extent of forest areas, population pressure, other resources of the nation, types of agricultural crops, prevailing land-use practices, land policies, climate and topography; but since the majority of the countries of this region are dependent on the use of the soil, it is easy to foresee that the future prosperity of the people depends upon successful formulation of a balanced land-use programme. Agriculture and forestry will each attain their highest development by maintaining a symbiotic relationship with each other.

Undoubtedly, there are many who would point to the vast reaches of virgin forest on the continental land masses and scoff at the need of any alliance with agriculture to make of forestry a going enterprise in those countries blessed with extensive forests. True enough, there can be no doubt about the extensiveness of the mixed tropical forest in the western hemisphere, estimates of which run into millions of acres. Why then has there been such a definite lag in the development of tropical American forestry, if, as we know very well, thriving communities existed in this region long before the first log cabins were erected within the boundaries of the United States? Based on years of personal experience in tropical forestry and extensive travel in both hemispheres, Major Oliphant* has very adequately attributed the backwardness of tropical-forestry development to the following four factors:

1. Wood is a commodity of low value per bulk and only high-priced woods can bear transportation costs to distant markets.
2. Virgin tropical forests contain a much lower percentage of high-grade wood than those of temperate zones.
3. Local demand is small per capita.
4. Technical backwardness in utilisation and transport.

* Oliphant, J. N., Director, Imperial Forestry Institute. "The Development of more Intensive Use of Mixed Tropical Forest." "Empire Forestry Journal," 16 (1), 1937.

The truth of the first factor may readily be checked by a consideration of the number of tropical American timbers which are presented for sale in northern markets. Only a very few species are well known and this fact is still more striking if considered in the light of the immense number of tree species existent in tropical regions. As an example of this complexity of flora, the island of Puerto Rico, which is roughly 105 miles long by 35 miles wide, contains over 500 native tree species.

Among this great number of species, we find many more producing timber of high value in the forest than in northern markets, but, nevertheless, the majority of the individual trees to be found in virgin forests are of little value, even when close to a market. Silvicultural operations to convert a virgin stand of this nature into one more similar to those of temperate regions is possible, but is being carried out in very few places in the American tropics. The widespread system of culling forests of the better species, followed by invasion of weed species, always results in an inferior forest, and one with which it is very difficult to carry silvicultural operations without large expenditures. Oliphant says of this, "One of the most difficult problems of tropical forestry is that of securing release from interests vested in selective exploitation, so that this tragedy of misuse may be brought to an end, a process that must of necessity be very gradual." Although the necessity for discontinuing such culling of the forests is perfectly obvious, it is extremely doubtful if such can be obtained on any considerable area, unless a rapid realisation occurs on the part of the officials of the various countries represented.

The third factor of the small per-capita local demand is readily appreciated when one considers the large class of poor people in the tropics who have little need for and less money to purchase timber or wood products. Also, the climate combines with poverty in obviating the necessity for wood consumption. Shelter can be provided with a thatching of grasses or other non-timber material over a framework of small poles, and firewood can be obtained, from brush if larger material is not available. Since illiteracy is common, products from wood pulp, such as newsprint or paper, are relatively low and it is doubtful that the general per-capita consumption will be greatly increased in the near future. As a matter

of fact, other materials such as concrete and sheet iron are giving strong competition with wood products right up to the edge of the forest.

The last factor, that of technical backwardness in utilisation and transport, ties in closely with the first and second factors. Naturally, with a low percentage of high-grade woods per unit area, it is impractical to establish expensive systems of transportation. Along with this go such factors as the difficult topography encountered in so many sections of the tropics, the heaviness of the wood of many species which makes water transportation impossible, and the great distance by steamer to northern markets. As for utilisation, local markets are often well informed by experience as to the relative values and uses of a great many species occurring in the surrounding forests, but, as far as northern markets are concerned, very little progress has been made in the introduction of other than a few already well-known species. The task of making requisite studies of utilisation and introducing new species to an always doubtful public is rather heavy for any private corporation to undertake, and leadership by governmental agencies of either the importing or exporting countries is necessary to establish such a product on a steady market.

Now that we have considered a few of the reasons which tend to retard the growth of tropical forestry, let us turn to a brief consideration of tropical agriculture. For a great many generations, the raising of food crops has been a going concern in the American tropics and the extent of land surface worked over for this purpose is still expanding due to two factors: the increase in population and the search for newer and better soils. As we have already noted, the per-capita consumption of wood is very low in the tropics, but the consumption of food, based as it is on more essential requirements, cannot be varied to any great extent no matter where the individual is located. Therefore, agriculture is relatively much more important to the poor man here than in the north, since shelter is easily provided, clothing requirements are fewer, and food stands out as the most important of needs. Thus, a predominantly rural population may go on increasing and spreading over the land area of tropical country without any apparent change in its status.

This process, providing as it does an adequate labour supply for the support of the upper levels of society of the country, seems like a perfectly healthy growth until a point is reached where new and fertile soils for agricultural expansion are not available. At about this same time concurrent with their increasing scarcity, comes a realisation of the importance of forest resources. But, because second-growth forests can still supply the essential wood requirements, even though of poorer quality, the main feeling of loss probably is connected with the rememberance of the fertile soils which were made available by the felling of virgin forests. From that point on, the depreciation of soils, diminishing of forest resources, and lowering of living standards of the people go hand in hand and the money and energy which must then be expended by the Government to bring about a stable land-use programme is out of all proportion to that which would have been necessary if sufficient foresight had brought about proper action in previous years.

One could contradict such dire predictions by referring to the fact that foresters of the United States of America have been pointing out for decades a rapid local exhaustion of timber supplies and yet their sawmills still go on cutting at the same rapid pace. However, regardless of whether or not that country is approaching a timber shortage, the two cases are not exactly comparable because in the United States the forests were felled mainly for the production of timber whereas in the tropics the greatest force acting against the forest seems to be that of shifting agriculture, a system which makes little use of the timber supplies felled and which adds little or nothing to the permanent prosperity of the country. There is another difference too in the rapid increase in population in tropical countries where health standards are raised.

The sketching of this brief and rough picture of land use is not intended as a prophecy of soil deterioration and timber shortages of nations but rather as an attempt to point out the role that forestry may play in the economy of tropical countries. As distinct from the prime emphasis on timber production in temperate zones, forestry in the tropics may well find itself concerned with the problem chiefly of amelioration of soils which have become "worn out" by too consistent agricultural use.

True enough, there are vast areas of fertile lowlands, either with abundant water or potentially irrigable, which are now or will be dedicated to prosperous, permanent, and continuous agricultural use. On the other hand, there are extensive areas of high mountain forests, arid or swampy woodlands, and other areas too rocky for either cultivation or grazing which will fall naturally into a classification of permanent forest sections. Between these two distinctly demarcated zones stretches a vast intermediate zone, usually comprising the major part of the country. This zone cannot support continuous cultivation without deterioration because of the nature of the soils, the topography, and the climate; also, because of its extent and under pressure of population, it cannot serve its highest purpose by dedication to permanent forestry. This is the zone where land-use evils first come into focus, where the farmers recall the "good old days" of fertile soils, the soil expert frowns at the soil erosion in progress, the forester points out the felling of the forests as the source of the evil, and most all unite in pointing at the system of "conuco" or shifting agriculture as prime evil which must be abolished at all costs.

But the tiller of the soil has no evil intentions in the back of his mind while sweating at the repeated, arduous task of clearing and breaking up new ground. His purpose of providing food for himself and his family is a most honourable one, and his ancestors found out in the long-distance past that this was the most practical system of agriculture for such a zone. In new, rich country, the garden patch may be abandoned because of the invasion of grasses and weeds, but where population becomes dense, erosion and leaching of the soil are the reasons which cause him to turn to a new clearing; and this may now be to a site of previous clearing where, following abandonment, grasses and lush herbaceous growth thrived, to be invaded later by brush and then by weed-tree species, so that, when he does return, he finds the soil considerably built up through the process of Nature's tending. Doesn't Nature herself, then, point out the obvious practice of an alteration of field crops with a forest crop as the most practical method to follow within this zone? Such procedure would require no radical change in a cultural system built up through many generations and it would seem

to offer a definite advantage to the cultivator to find ready for clearing, not a patch of brush and weed-tree species, but a real, planned forest crop convertible into cash.

The agricultural scientist is striving along many angles to work out the maintenance of soil fertility in this zone, yet allows Nature to sow haphazardly the woody species which help to build back the soil in abandoned fields. On the other hand, the forester is already using, in several places, inter-cultivation with agricultural crops as the most practical and least expensive of methods for establishing forest plantations. When will these two workers, from two sciences, rooted in the soil, get together and work out a real programme of land use which will benefit mutually their respective fields and the people of their country in general?

Thus, the agriculturist can go a long way towards solving his soil problems, can assure for his farm an adequate supply of construction timbers, fence posts, and firewood, and add an additional cash crop to his produce. The forester can overcome those factors which were listed early in the paper as retarding the development of tropical forestry, by producing stands with a large percentage of high-grade woods, sufficient to supply local needs and also to ensure northern markets of a continuous supply of first-quality woods which could be transported readily over the same routes which agriculture uses.

The breadth of the problem involved in this paper is too great to allow for more than the rough outline presented, and details of application would necessarily be different for each locality with its correspondingly distinct set of local factors. In Puerto Rico some progress is being made along this line which will be described in later articles. It would be extremely interesting to learn of any similar work in progress in other countries.

WOOD PRESERVATION

WHAT TESTS WITH "CELCURISED" PITCHPINE SHOW

During the past 20 years the demand for aqueous wood preservatives suitable for impregnating timber under pressure and being detained permanently and effectively therein has been on the increase in Great Britain and in America. The preservation of timber in America is conducted on a large and elaborate scale in an attempt to conserve their forest resources, which have been used up in the past in a prodigal manner.

The treatment in both countries has been chiefly by oils—creosote or a mixture of it and heavy oils applied by the vacuum-pressure method. Oil treatment, while efficient, is only suitable for outdoor work, such as railway sleepers, marine piles, etc., because of its oily and smelly nature. It is objectionable on that account for indoor work. Since the introduction of reliable aqueous preservatives, their use is now compulsory in certain States of America to treat the constructional timber of swelling-houses to prevent the attacks of termites (white ants) and fungi. The preservative to be used must be permanent, odourless, non-leachable, non-inflamable, clean to handle, and free from poisonous salts, *e.g.*, arsenic in any of its combinations.

These conditions, it is worth noting, are being satisfied by the British wood preservative called "Celcure." It has been under test by the Forest Products Research Laboratory of the U.S.A. since 1931, at their testing station at Barro, Colorado Island, Panama, against the attacks of termites and fungi, and, according to the latest report issued by the American Wood Preserving Association, the results are good after a period of eight years, and are continuing. The latest report from the Scottish Marine Biological Station, Millport,—also after eight years—shows that "celcurised" wood is immune from the attacks of teredo (ship worm), Limnoria (Gribble) and Cheluria, while two sets of "Controls," *i.e.*, untreated specimens, have been destroyed in that time.—*Timber Trades Journal, Vol. CLIII*, No. 3326, dated 25th May, 1940.

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EXPERIMENTS WITH EXOTICS

(PAPER I)

Fifth Silvicultural Conference, 1939, Item No. 21

THE INTRODUCTION OF EXOTICS

BY R. N. PARKER, I.F.S.,

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Few activities of the Forest Department seem open to more criticism than experiments with exotics and it must be admitted that much of the criticism is justified. I have heard people go so far as to say they do not believe in exotics. Those who make such statements speak first and think afterwards or probably more often they omit the thinking altogether. The obvious reply is to mention a few exotics, e.g., potatoes, maize, tobacoo, etc., and ask which of these they do not believe in. At this point the attack changes its ground and one is probably told that exotics may be all right for horticulture and agriculture but are all wrong for forestry. This argument overlooks the fact that exotics are already used in Indian Forestry with great success, e.g., Casuarina on the sea coast and Mulberry in irrigated plantations.

The objections that should be raised against experiments with exotics should be directed not against exotics in general but at the species selected for the experiments. The fact that a particular plant has done well under certain conditions in a foreign country is no justification for assuming that it will do equally well under totally different conditions in India. Rather one should assume that it will fail.

According to the *Kew Bulletin of Miscellaneous Information*, April, 1936, the Agricultural Department in the Punjab is trying *Spartina townsendii* on saline soil in the Punjab. This grass has done well on the sea coast in temperate climates. Obviously, therefore, it is exceedingly unlikely to thrive in a sub-tropical semi-desert climate. It would not be easy to select conditions more dissimilar

than the plains of the Punjab and the sea coast in moist temperate regions and to expect a plant from one of these areas to thrive in the other shows complete ignorance of the requirements of plants. It would be just as reasonable to try mangroves on saline soils in the desert. Highly specialized plants such as mangroves will not thrive under conditions very different from those to which they have become adapted. It is not, however, for the Forest Department to cast the first stone at anyone in the matter of trying exotics. Some 30 years ago marram grass was being tried in the arid rocky hills of the Punjab. The idea seems to have been that since marram grass builds up dunes from drifting sand, it would, in some miraculous way, build up soil on rocky hills. It never had the chance to do this since it never grew more than two inches high and died apparently from heat and lack of atmospheric humidity.

There are instances, very few and far between, of plants thriving under conditions very different from those of their native habitat. The two best known are perhaps *Broussonetia papyrifera* and *Grevillea robusta,* both plants native of moist tropical areas but which thrive in Upper India. To search for such plants is, however, like hunting for the proverbial needle in a hay-stack. They may be found accidentally as the result of trials of species in botanic and horticultural gardens. Practical forestry cannot afford to search for such rarities though it might make use of them when they are discovered.

In trying exotic species in forestry, therefore, it is essential if the search is not to degenerate into aimless experimenting, to select species which are likely to thrive owing to their being natives of countries with a closely similar climate. In comparing climates, it is necessary to consider extremes of heat and cold as well as the mean temperature and also the season of rainfall, whether summer rain or winter rain and length of periods without rain as well as the total amount.

Under Indian conditions a successful exotic should usually be one that will regenerate naturally. When one sees the large numbers of exotic weeds that are naturalised in India, one is tempted to ask if the countries that furnished the weeds cannot give us something useful as well. They doubtless can do so but successful

weeds are usually very widely distributed in their native countries, either naturally or as a result of cultivation, whereas useful trees are usually much more limited in their distribution and, therefore, less likely to be generally useful in India and more difficult to place correctly in situations in which they will thrive.

It may be taken as a general rule that a plant that has a wide distribution in its native land is likely to be more adaptable to cultivation in another country than one that has a very limited distribution. One of the most successful and easiest species of Eucalyptus to grow in Upper India is *E. rostrata*, a species found in every state in Australia. There are, of course, exceptions to this rule as *Cupressus macrocarpa* and *Pinus radiata*, both species confined to a small area in California, have been very successful and often regenerate naturally when tried in other countries.

We may consider a question which is very obvious but which has frequently been overlooked: Are exotic species necessary and desirable? If so, are they wanted in the places where they have been tried and are likely to thrive? If we take the deodar zone in the Himalaya where various species of pine have been tried, the answer to these questions is probably in the negative. No pine produces a timber as useful under Indian conditions as deodar and hence an exotic pine is not wanted in the deodar forests. A pine which would grow on hot, dry slopes where deodar does not grow readily might have a limited use as a nurse for deodar, but otherwise there is no place for a pine. On the other hand there is a zone in the Himalaya which should be occupied by *Pinus longifolia* and is so occupied where quartzite comes to the surface. Where the geological formation changes to mica schist these slopes are bare except where the elevation of aspect allows *Pinus excelsa* to grow. A fire-resistant pine such as *Pinus ponderosa*, if it would succeed, would enable these slopes to carry a useful forest growth.

When the Forest Department in the Punjab was experimenting with Robinia it was tried from the plains to 9,000 feet without asking whether it was likely to thrive under all these conditions and without enquiring whether it was wanted throughout this zone. No indigenous tree will thrive from the plains to 9,000 feet and it

is unfair on any exotic to expect it to do so. There has been a tendency in the past to expect an exotic to thrive under conditions in which indigenous species have failed. When the exotic also fails, all exotics and experiments with them are discredited. This attitude is most unreasonable but has been very prevalent. It cannot be too strongly emphasised that if an exotic species is worth having, it should be in some respects better than the indigenous species and, consequently, it would be worth while, if it is possible to do so, replacing the indigenous plants with the exotic one. Exotics should, therefore, be tried under favourable rather than under unfavourable conditions. To try a useful exotic species in conditions under which indigenous species would fail is merely waste of time. Failure under such conditions gives no information of value. In trying an exotic the object should be to obtain some specimens the growth and development of which can be watched. If an exotic species fails or does not come up to expectations under favourable conditions it can be written off as useless and some definite knowledge is gained.

A consideration that is sometimes overlooked is the use that is to be made of an exotic species that can be grown successfully. If it is a tree that is to be used for firewood no difficulty in marketing is likely to arise. If it is a timber, marketing of the produce is likely to be difficult. If a few trees of teak or mahogany were available for sale in the Punjab, a satisfactory price could no doubt be obtained for them as these timbers are well known. On the other hand, if scantlings cut from half a dozen larch trees were received in a timber depot, they could not be sold on their merits as timber. They would probably be sold as blue pine and not as larch. It would be little use selling them separately as larch if no more were likely to be available for many years. An exotic timber tree, therefore, will have to be grown on a fairly big scale so that a regular supply is available if it is to be sold on its merits as a timber. Timber consumers will have to learn its value before they will pay the full price.

I do not think the term "exotic" has ever been satisfactorily defined and it does not seem capable of a satisfactory definition. Popularly and loosely used, an exotic species is one from another country. This is clearly no scientific definition and very unsatisfactory. Under this meaning of the term it might be argued that a

Burmese tree grown in India was not an exotic originally but became one on the 1st April, 1937. This brings one to the question whether a tree grown slightly outside its natural limits is to be considered an exotic or whether a tree grown in an area inside its natural limits but in a locality where it is not found naturally is an exotic. I do not propose to answer these questions but merely to point out that many of the objections to exotics apply equally to these cases. Forest officers who have no respect for exotics do not hesitate to grow a tree either beyond its natural limits or in places where it does not occur naturally. It has been done on a large scale with deodar, in some cases, with not very happy results and in others the ultimate results remain to be seen. Before growing a tree such as deodar in an area where it is not found naturally but within its area of distribution it is advisable to consider why it is absent. If conditions have changed, through fire protection, for example, an area formerly unable to produce deodar may now be well suited. If, on the other hand, there is no very obvious reason for the absence of deodar in an area where one would expect to find it, there is, at any rate, a possibility that there is a good and satisfactory reason for its absence of which we at present are in complete ignorance. To try to grow deodar under such conditions is, in my opinion, quite as much a gamble as to try an exotic such as larch. We know that larch is absent because the seed has not been able to get there, but the absence of deodar is not due to this cause. I do not wish these remarks to be misunderstood. I am not advocating the extensive planting of larch or any other exotic, but merely wish to point out that under certain conditions, if we are not satisfied with the crop Nature has given us, an exotic species, such as larch, which has been grown in the deodar zone with satisfactory results, is at least as worthy of a trial as deodar.

In extending the area of natural distribution of a species, the Cypress appears to be worth attention. Cypress in the Himalayas is widely distributed but of very local occurrence. In former times, presumably, it was more abundant than it is now and has perhaps been driven out by competition with other species from most of its former area. If this is the case, its present area could easily be extended. Another case where the trial of exotic species is indicated

is the Salt Range. These dry, arid hills are connected with the foothills of the Himalayas and the Trans-Indus hills. Their flora has been derived from these sources though climatically they resemble in many respects the hills of Rajputana. From the hills of Rajputana they are separated by a wide expanse of plains with a different flora. It seems possible that the flora of the Rajputana hills is as well suited to the conditions of the Salt Range as the indigenous vegetation and possibly even better suited. This view merely supposes that since the Ice Age the Rajputana hill flora has not been able to jump the gap of the plains and colonize the Salt Range. The two chief trees of the Rajputana hills, *Acacia senegal* and *Anogeissus pendula,* have both been introduced in the Salt Range area. The former has already shown signs of regenerating naturally in the Pabbi hills where it was first tried.

Finally, there is a case, unfortunately too common in the Punjab and likely to become universal, where owing to erosion and consequent lowering of the factors of the locality, much of the indigenous vegetation is dying out. The hardier members of the old flora increase and the vegetation takes on a more xerophytic aspect. Protection and remedial action is taken too late to save the original flora in its entirety and we must be content with only its hardiest constituents. In these cases if a forest crop is to be reconstituted, it is necessary for the more arid and exposed sites to select plants from an area naturally more arid. In the case of the Hoshiarpur Siwaliks, where sowings have been tried, typical Siwalik plants are not used to any great extent. The main species used is *Acacia modesta,* a typical Salt Range plant which is rare in the Siwalik in undenuded places. Recently *Acacia senegal* from the Rajputana hills has been tried and promises well. It is natural in such cases not to look very far afield for likely species because we know something about species from neighbouring areas and their requirements and can usually obtain the seed without difficulty. There is, however, no real reason to suppose that a species selected from the Rajputana flora is any more suitable than one selected out of the Mexican flora for growing in the Hoshiarpur Siwaliks. A carefully chosen Mexican species might well give just as good results or even better. The Mexican species would, however, have to be carefully chosen which

presupposes some knowledge of the conditions under which it grows in Mexico.

In conclusion, I do not think there is any reason for not experimenting with exotic species provided a little commonsense is used. Firstly, the exotic species should have some quality such as rapid growth, valuable timber, ease of cultivation, etc., which gives it an apparent advantage over the indigenous plants. Secondly, it should come from a climate as similar as possible to that of the locality in which it is to be tried. Thirdly, something should be known of its requirements. It is useless trying a plant from an arid region under normal arid conditions if the plant in its native habitat is only found growing along streams. Finally, the first trial should naturally be made on a small scale and in an accessible locality or it will be lost sight of. Half a dozen specimens of a likely exotic in the corner of a rest house compound would show our successors whether the tree was worth a more extensive trial and provide seed for further use if it were required.

GRAZING VERSUS BURNING AS AN AID TO SAL REGENERATION

BY J. B. ROWNTREE, I.F.S.

A great deal of research has been carried out and much has been written on the subject of sal regeneration, and thanks to the work of pioneers such as Milroy in Assam and Smythies in the United Provinces, to mention but two, and to those who have followed after them, we now know a great deal about this important subject. The question of grazing and its effect on sal regeneration does not, however, appear to have received much attention, and in this short article I propose to discuss this factor and to try to come to some conclusion as to its importance.

My own experience of sal regeneration has been confined to Kamrup Division in Assam and the following remarks apply to what is known as "The Kamrup Method." A short history of the Kamrup Sal Forests will not, therefore, be out of place.

Up till 1914 the Kamrup sal reserves were fire-protected and the original sal-thatch sub-climax was rapidly being replaced by an ever-

green one in which sal advance growth was almost entirely absent. Milroy had noticed that in the Unreserved State Forests which were periodically burnt and where what are known as "Boko conditions" prevailed, advance growth in association with thatch (*Imperata cylindrica*) was profuse. Many of these areas have since been reserved and now form part of our present P. B. V (*see* Plate 45, Fig. I). He, therefore, took the bold step of abolishing fire protection and, under his plan, a system of improvement fellings, combined with controlled burning of the reserves, was introduced. Milroy considered that by this means thatch would come in and that under these conditions sal would be able to reproduce itself. Thatch soon began to replace the evergreen undergrowth but it was not for about ten years that sal regeneration was noticed to any extent. Once started, however, it soon began to increase and large areas became covered with advance growth.

Milroy realized that sal must have light to establish itself. He experimented with groups in which the entire canopy was removed. The diameter of the groups being equal to approximately twice the height of the upper canopy. These experiments gave encouraging results and this method formed the basis of Bor's plan which came into force in 1929.

Under this plan Bor prescribed clear-felled groups and strips in the P. B. I. and removal of "Kukat" (non-sal species) in between, combined with systematic burning of the ground cover so as to encourage the introduction of thatch. Much adverse criticism has since been levelled at the introduction of this plan, which did not prove to be as successful as had been hoped would be the case, on the grounds that it had been introduced before the system upon which it was based had been fully demonstrated. This is doubtless quite a fair criticism but there is no doubt that it would have been successful if it had been properly worked. Some of Bor's original groups contain excellent advance growth which is now established (*see* Plate 45, Fig. II, and Plate 46, Fig. I); but, unfortunately, many of the groups were made far too big with the result that they became swamped with weeds which were not cleared in accordance with the plan prescriptions. "Kukat" was also removed wholesale without due regard to the density of the sal canopy. By this time

Fig. (1)

P. B. V. area formerly included in Unclassed State Forests and subject to fierce fires. Clearing of poles completed after emergence from fire protection.

Fig. (2)

Sal seedings in an old group in Modoki Compartment subject to annual early burning and sporadic grazing.

Fig. (1)

Established Sal in old group in Khubdia Compartment now under fire protection. Formerly subject to annual early burning and sporadic grazing.

Fig. (2)

Whippy Sal seedlings coming up under cover of *Eupatorium* in an opening in Bohutpur Compartment.

the weed *Eupatorium odoratum* was firmly established in Kamrup and invaded most of the areas where the canopy had been removed; and where it was absent the thatch became so dense that in either case the existing advance growth was smothered. (*See* Plate 46, Fig. II.)

Experiments were next carried out to see if the *Eupatorium* could not be controlled by rains tending. Luckily Kamrup is well off for forest village labour and it was found to be a simple matter to clear it by hand pulling during the rains. It was also discovered that this weed is an excellent nurse for young sal and that where it exists it is usually full of sal recruitment which cannot, however, establish itself until the *Eupatorium* is removed. It was also realized that it was very dfficult to avoid some of the groups being lost sight of.

Under Jacob's plan, therefore, the uniform system was introduced in which controlled burning was continued combined with rains tending, *i.e.*, cutting back of evergreens and hand pulling of *Eupatorium*; and "kukat," instead of being felled wholesale, was thinned out uniformly along with the sal. This had the added advantage of helping to keep the growth of thatch and other types of undergrowth in check until the advance growth became strong enough to compete with it. This plan was introduced in 1939 but many of its prescriptions had actually been in force for four or five years.

This briefly is the history of the Kamrup Method.

The results have been highly successful and now it is difficult to find anywhere in the P. B. I. Compartments where advance growth is absent, and large areas are nearly ready for fire protection or have already been protected. It remains to be seen what the various factors are that have led to its success.

I think it is generally agreed that the following have been the deciding factors:

1. The early improvement fellings and the return of a sal-thatch sub-climax brought about by burning, encouraged new recruitment which had been unable previously to appear on account of the denseness of the canopy and unsuitable ground cover.

2. The subsequent opening up of the canopy under the uniform system combined with:
3. The control of the ground cover, has enabled these seedlings to reach the whippy stage and in many cases already to have established themselves.

I do not propose to discuss the question of canopy manipulation and rains tending. Our conclusions in Assam regarding these operations agree, I think, with those so ably set forth by Smythies in his recent articles which have appeared under the title of "Sal Regeneration De Novo." I propose to confine myself to the question of grazing, of which so far no mention has been made, and of burning.

First of all, let us consider what burning is said to have done for these forests:

(*a*) It is said to have helped to get rid of the evergreen shrubs and *Pollinia* and to allow thatch to come in.

(*b*) It is claimed that it has reduced the intensity of the thatch, preventing it from smothering the sal regeneration and, at the same time, preventing the mother trees from becoming scorched by late fires.

(*c*) In the form of a leaf burn it is supposed to have a beneficial effect in allowing the sal seeds to take root.

Regarding (*a*) I do not think that any one will deny that this is the case and that without the use of fire it would have been impossible to get back to the sal-thatch subclimax, except perhaps at enormous expense. Regarding (*c*) it seems that in Singhbhum they get on without a leaf burn and Warren, in a recent article, considers this operation to be both harmful and unnecessary. It is certainly true that many seedlings are killed by the leaf burn but new recruitment must surely be greatly increased thereby. Of course, in the later stages, when the canopy has been opened up, the leaf fall is not nearly so heavy and perhaps a burn is then not necessary; but in Assam we try to get new recruitment in our P. B. II and Inter P. B. Compartments where the leaf fall is very heavy, forming a mat on the ground, and here I consider it cannot be dispensed with, although this point seems to require further research. It is with regard to (*b*), however, that the question of grazing comes in.

I do not consider that either grazing or burning have any direct effect in producing new sal recruitment or in the subsequent growth of the seedlings. Some of our Forest roads which are completely void of any vegetation form excellent seedbeds during June and July and, no doubt, if left to themselves, and if the soil was suitable, the seedlings would soon become established. The importance of both grazing and burning lies in their power to control the undergrowth, particularly thatch, and thereby to assist the growth of the sal seedlings.

Two kinds of thatch are found in these forests—a coarse, high kind known locally as "Batta," and a fine light kind known as "Ullu" thatch. Both have been identified as different forms of the same species *Imperata cylindrica*. The latter type is usually found in heavily grazed areas such as village grazing grounds, and the former in its extreme form in places where no grazing takes place. It is, I think, generally recognized that intensive grazing or burning depauperates the thatch and reduces it from the heavy to the light type. It is also undoubtedly a fact that sal can regenerate itself and become established comparatively easily in "Ullu" thatch whereas it can only do so with great difficulty when "Batta" is present. It has already been pointed out that once the canopy is opened up, and this operation is necessary in order to establish the advance growth, the thatch becomes much more luxuriant and tends to suppress the sal seedlings.

The whole crux of the matter lies, therefore, in the control of the thatch and the question to be decided is: Which of the two operations—grazing or burning—is the critical factor? In the past, burning has been held to be the *sine qua non* and grazing has been looked upon only as a useful accompaniment. It seems probable, however, that this view should be reversed.

One of the reasons given, that burning, and not grazing, is the deciding factor, is the fact that grazing has always been allowed in these reserves but that it was not until burning was introduced that regeneration was obtained except along the fire lines and roadsides. It is also pointed out that there are some places especially in the hill reserves where plenty of advance growth is to be found but

where grazing has been non-existent or very slight, but which are periodically burnt. (*See* Plate 47, Fig. I.)

This is quite true but it is not as simple as all that. I have spoken with some of the oldest inhabitants of our forest villages who remember the old fire protection days and they tell me that the jungle was then so thick that they only grazed along the fire lines, the road-sides and in the open spaces outside the reserves; in fact, in those very places where sal recruitment was to be found. In the case of the hill reserves also other factors come into play. For instance, these reserves are full of the bamboo *Dendrocalamus hamiltonii* which forms an excellent nurse for sal and moreover thatch does not grow nearly so luxuriantly there as it does in the plains; and in the case of those plains compartments which contain advance growth but where little, if any, grazing goes on, conditions may now be quite different to those in force when recruitment took place. There may have been grazing in the past or the new recruitment may have taken place under *Eupatorium* which has since been removed and has given way to thatch. It is significant that in Goalpara Division where there is practically no grazing in the reserves the regeneration of sal is still a problem which has not been fully solved. It should also be bourne in mind that the sal did not begin to regenerate itself in Kamrup for about ten years after controlled burning had been introduced, that is to say, until the thatch had come in and grazing had presumably started. The importance of grazing cannot, therefore, be lightly dismissed.

One thing that has struck me particularly in this connection is the fact that most of the more advanced patches of sal advance growth, many of which have now formed pole crops, have sprung up on roadside land and in places near villages which have been heavily grazed in the past (such a heavily grazed area is shown in Plate 47, Fig. II). Such places originally had a covering of light "Ullu" thatch which was overgrazed and which was full of suppressed seedlings. Some five years ago, many of these areas were fenced and protected from grazing and this advance growth rapidly established itself. (*See* Plate 47, Fig. 3.)

The other day, I was reading an article by Smythies written in 1936 and entitled: "Seedling Regeneration in B—3 Sal." With

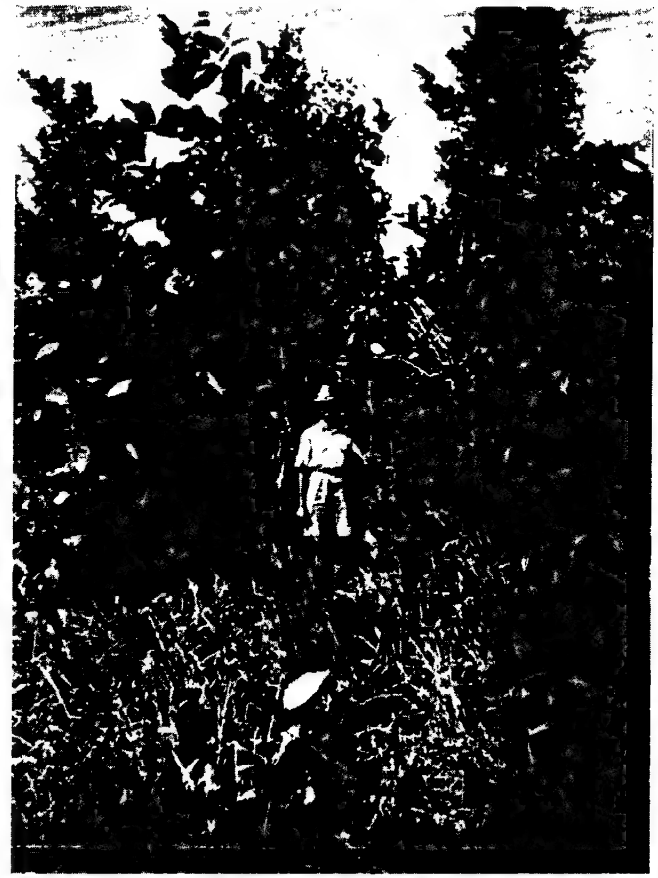
Fig. (1)

Sal seedlings on an island in Sandubi Bil. Subject to annual early burning but not to grazing.

Fig. (2)

Heavily grazed area in Bohutpur Compartment. Thinning of *kukat* just completed.

Fig. (3)



Patch of established sal in Kokapara Compartment now under fire protection and protected from grazing, formerly subject to annual early burning and grazing.

regard to the Bhinga and Kota Dun blocks he says: "Both areas have had the same past history, *i.e.*, an open sal forest intensely overgrazed by village cattle and then suddenly closed to grazing about 15 years ago. Intense overgrazing is a recognized form of forest destruction; is it a mere fluke and coincidence that the two worst grazed areas in the Province 15 years ago should now be the two best regenerated?" He goes on to say that he does not, however, advocate intense overgrazing as a sure method of sal regeneration. Personally I do not think that it is coincidence at all. I consider that the overgrazing has had a depauperating effect on the thatch and that the seedlings, although the shoots had been suppressed, had developed a strong tap root and were able to respond immediately grazing was stopped and, before the thatch could catch up, had established themselves. The answer to this theory is that it is not the grazing that has done the trick but the fact that the villagers burn their grazing grounds annually in order to encourage the new growth of thatch, and also remove "Kukat" for firewood and house-pests from these areas adjacent to their villages. It may, therefore, be surmised that it is the constant burning, combined with the opening up of the canopy by the removal of "Kukat," which has brought about conditions favourable for sal regeneration in these places.

This view may be correct but I am personally in favour of the former one. Intensive burning may reduce the thatch but early burning as carried out in Kamrup is a very different thing to the fierce fires which run through the Unclassed State Forests. It is an extremely mild affair and is only sufficient to shrivel up the leaves of the thatch and thereby kill them. Early burning alone may reduce the vigour of the thatch somewhat but it will never turn "Batta" into "Ullu," at least I have never come across a case, whereas grazing coupled with early burning undoubtedly will; and would probably do the same without the early burning.

Once advance growth has got a start, *i.e.*, when it has come in in a grazed area consisting of "Ullu", or when it has been recruited under *Eupatorium*, then early burning will keep the thatch sufficiently in check to allow the advance growth to establish itself, although I do not think it will prevent the thatch from reverting to "Batta,"

but when the ground cover consists of "Batta" thatch with no recruitment, then I do not consider that any amount of early burning will ever reduce it to "Ullu," and, unless grazing is introduced, it will be an extremely slow job if not an impossible one to get new recruitment and to establish it.

Nearly all the compartments in Kamrup which contain good advance growth have, in the past, been fairly heavily grazed or else have contained *Eupatorium* or bamboos which have acted as a nurse for the young seedlings; whereas those in which there is no grazing and where *Eupatorium* and bamboos are absent are usually full of coarse "Batta" thatch and contain very little advance growth.

For those who know Kamrup, the following examples will be sufficient to illustrate my point.

The first "tari" of Dakhin Sandubi Compartment, which has been heavily grazed by village cattle, is full of advance growth whereas the other "taris" contain less and less the further one gets away from the village; and mention could be made of numerous other compartments which contain excellent regeneration and which have either been heavily grazed or which contained *Eupatorium* or bamboos. Maj Phuljola, Kokapara, Manikpur, Dhonipara, Dakhin Nampathar and Barbakra are all good examples. On the other hand, such compartments as Moira Nadi and the portion of Dakhin Sandubi mentioned above, where grazing is unobtainable, are excellent examples of the other kind.

I do not suggest that it is advisable or even possible to replace early burning entirely by grazing because the incidence of grazing would then have to be increased to such an extent that it would not be possible to control it, and, moreover, it is impossible to get people to graze everywhere. Also cattle do not appreciate thatch which is never burnt and buffaloes, except perhaps in extreme cases, should not be encouraged. I consider that burning and grazing should be combined as, in fact, is done at present, but that more attention should be paid to grazing than in the past; and if some of the areas where sal regeneration has proved refractory were really heavily grazed for two or three years, I feel confident that they would soon be full of advance growth, and that if such areas were then protected from grazing, this advance growth would very soon be established.

This is, I realize, a somewhat revolutionary suggestion, but so was the introduction of controlled burning. I suggest that such a drastic step should only be taken, to begin within those places where we are experiencing real difficulty in getting regeneration and establishing it and such places are luckily few and far between. In other places where the thatch is light even though it may be of the "Batta" variety, sporadic grazing is being tried in addition to early burning as a means of keeping the thatch in check, and, so far, has shown good results. Detailed experiments on these lines should be started in order to collect actual data and I believe that some such experiments are soon to be made by the Provincial Silviculturist, which I hope will give interesting results.

NOTE ON THE GERMINATION OF SCAPHULA (ANISOPTERA) GLABRA

By M. V. Laurie

Central Silviculturist

Summary.—"Anisoptera glabra" seeds, when sown with the wings upwards, suffer high percentage of casualties, and the surviving seedlings are badly contorted. Clipping the wings and sowing the seeds upside down produced higher percentage of survivals and stronger, straighter seedlings.

What follows may be stale news to some readers, and to them I tender an apology. To others, this experiment may perhaps be of sufficient interest to make its publication in these pages worth while.

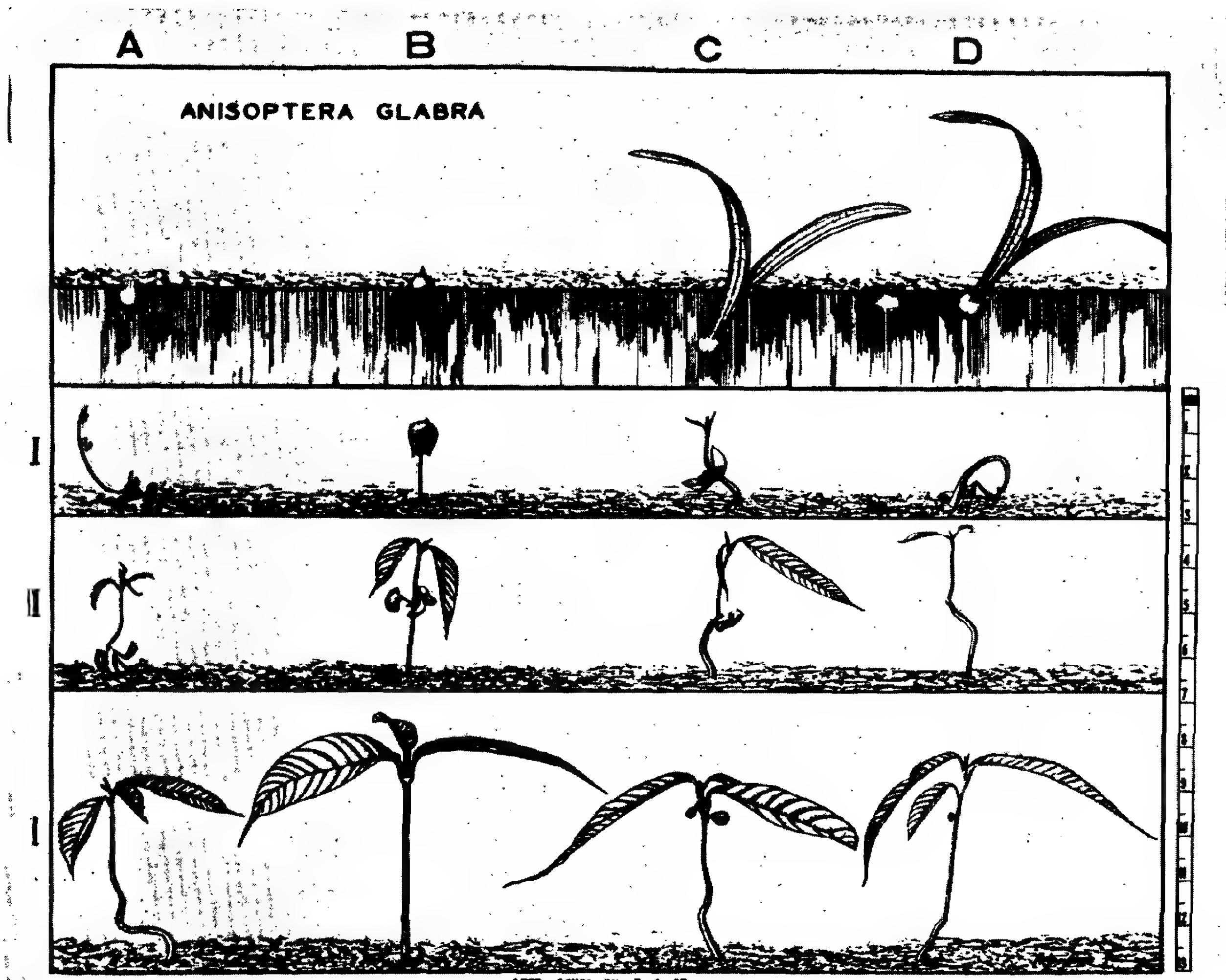
When on tour in Chittagong Division in Bengal in 1936, I was informed that great trouble was being experienced in raising Boilam (*Scaphula glabra*). This is a *Dipterocarp* that produces a valuable timber fetching good prices, but the tree exists only as scattered individuals here and there, and attempts were being made to increase the supply by planting it. I was asked by the Silviculturist (Mr. C. K. Homfray) if the Forest Research Institute could help in finding out how to get seedlings established.

The trouble was that when the winged seed was sown in the usual way, pushed into the ground with the wings upwards, the

germination took place in the normal manner, the radicle coming out upwards supported on the petioles of the cotyledons, but instead of arching over and descending to earth like any respectable *Dipterocarp*, it writhed about like a possessed spirit, and a large percentage gave up the ghost after tying themselves in knots. Tales were told of solicitous forest guards going round untying the knots and straightening out the twists and turns, but all with very little effect. The percentage of survival remained miserably low. There is little doubt that the contortions were accentuated by trying to grow the tree in clear-felled areas while it was naturally accustomed to germinate in the humid shady conditions of a tropical evergreen forest.

When seed was first received at Dehra Dun, it was not properly realised what the trouble was, and the first experiments consisted of trying various different seed coverings. The seed arrived stored in damp sawdust as, like most other *Dipterocarps*, it was suspected to be very perishable. The results of these first tests, in which germination occurred in eight days, showed immediately what the matter was. Even under the shade of the laboratory roof the radicles could not stand the exposure to dry air and many started writhing and twisting and dying back from the tip. About 56 per cent. initial germination was obtained, with no appreciable difference in the various media used for covering the seed.

Another experiment was immediately carried out, in a nursery bed, this time with sowings done as described in the illustration in Plate 48, which gives full details of the method and the results. Methods A, C and D continued to show writhing and a high percentage of casualties, but sowing the seed upside down. Method B gave the best results with higher survivals and rows of seedlings as straight as soldiers in marked contrast to the squirming and kinking of the seedlings from the other three methods of sowing. The seedlings from B also showed a distinct advantage in vigour due probably to their roots becoming established more quickly. It is likely that in other species of *Dipterocarps*, especially the large-seeded ones, inverted sowing may be similarly advantageous.



SEED SOWN ON 7-6-37.

A _ SEED SOWN BURIED WITH APEX UPWARDS TO THE DEPTH OF SEED LENTH,- WINGS CLIPPED.

A I _ SEEDLING AFTER 34 DAYS OF SOWING NOTE ROOT TIP DRYING BEFORE IT HAS TURNED DOWNWARDS.

A II _ SEEDLING AFTER 44 DAYS. RADICLE AFTER TURNING OVER HAS JUST FOUND THE GROUND.

A III _ SEEDLING AFTER 52 DAYS. NOTE THE TWISTED STEM.
PERCENTAGE SURVIVAL 55.

B _ SEED BURIED ½" DEEP WITH APEX DOWNWARDS AND STALK ENDS UP.-WINGS CLIPPED.

B I _ SEEDLING AFTER 34 DAYS OF SOWING. ROOT ELONGATED BUT COTYLEDONS HAVE NOT YET BURST SEED-COAT, AND PLUMULE HAS NOT YET EMERGED.

B II _ SEEDLING AFTER 44 DAYS. TYPICAL STRAIGHT NORMAL GROWTH AFTER EMERGENCE OF PLUMULE.

B III _ SEEDLING AFTER 52 DAYS. TYPICAL STRAIGHT AND HEALTHY STEM WITH 2 FULL SIZED LEAVES. PERCENTAGE SURVIVAL 66.
THIS IS THE BEST METHOD OF SOWING.

C _ SEED BURIED ON EDGE 1-1½" DEEP AND SLANTING.

C I _ SEEDLING AFTER 34 DAYS OF SOWING PLUMULE EMERGED, A LATER STAGE THAN B I.

C II _ SEEDLING AFTER 44 DAYS. BENT STEM DUE TO TWISTING OF RADICLE TO REACH GROUND.

C III _ SEEDLING AFTER 52 DAYS. NOTE BENT STEM.
PERCENTAGE SURVIVAL 40.

D _ SEED BURIED TO NORMAL DEPTH I.E. THICKNESS OF SEED, WINGS SLANTING UP.

D I _ SEEDLING AFTER 34 DAYS OF SOWING. TYPICAL TWISTING OWING TO VERTICAL UPWARD EMERGENCE OF RADICLE. SUCH PLANTS OFTEN FAIL TO DRAG COTYLEDONS OUT OF THE GROUND.

D II _ SEEDLING AFTER 44 DAYS. BENT STEM DUE TO TWISTING OF RADICLE TO REACH GROUND.

D III _ SEEDLING AFTER 52 DAYS. TYPICAL BENT STEM. PERCENTAGE SURVIVAL 48.

Seedling studies of *Scaphula* (*Anisoptera*) *glabra*. Seed sown by different methods.
D. A. New Forest. *Photo: N. Bakhshi. October, 1937.*

ARBOR DAY IN HAZARIBAGH

The Kanhari Hill Park and Land Improvement Scheme

BY C. S. JHA, I.C.S.,

Deputy Commissioner, Hazaribagh

On the 7th July, 1940, an important event took place at Hazaribagh. This was the first celebration of "Arbor Day" in the Province of Bihar. The place selected for the occasion was the Kanhari Hill Park and Land Improvement Scheme near Hazaribagh town. Readers of the *Indian Forester* will remember that a reference to the scheme was made in the lecture delivered at St. Columbas College, Hazaribagh, by Mr. J. W. Houlton, C.I.E., I.C.S., who originated the scheme and which was printed in the *Indian Forester* of April, 1940. A feature of the scheme which is of unusual interest is that it attempts to combine beauty and utility, in that a portion of the fenced area will be developed as a park with ornamental trees, a lake, etc., while the remainder will be devoted to experiments in re-afforestation, preventation of erosion and eradication of lantana, etc., as described below.

The park and land improvement scheme had an excellent start. His Excellency Sir Thomas Alexander Stewart, K.C.S.I., K.C.I.E., I.C.S., Governor of Bihar, and Lady Stewart, visited the site on the 11th May, 1940, and His Excellency declared the park open. His speech on that occasion showed his interest in the problems of disforestation and soil erosion and deterioration, which have become so acute, particularly in Chota Nagpur, and his appreciation of the value of the work being done at Kanhari Hill. He was particularly impressed by the fact that the scheme had been started and financed by private enterprise, and said that Government would follow its progress with great interest.

The following is a summary of the objects of the scheme:

This scheme was started in the rains of 1939 with the following objects:

1. *General.*—To undertake experiments in afforestation, prevention of erosion, checking excessive runoff of water, eradication of lantana, irrigation and improvement of grazing on a typical hill, with forest and eroded land adjoining it. The Kanhari area was selected as typical of much of the Chota Nagpur country, and as giving scope for all the above experiments. It is near the town and so will have maximum value as an object lesson.

2. To check the rapid washing off of soil from the hill, which threatened to convert the greater part of it into bare rock in a few years.
3. To re-afforest the hill with suitable trees and bamboos. At present the hill is practically denuded of vegetation, except lantana and other bushes, all trees having been cut down or lopped annually for very many years.
4. To clear lantana from the level ground south of the hill, and to carry out experiments in eradication or destruction of lantana.
5. To improve the existing sal forest south-east of the hill.
6. To construct a dam across the eroded valley and nullah south of the hill and create a small artificial lake. A brick or concrete runway for surplus water to be made. The lake to form a reservoir for irrigation and afforestation purposes. Carp and other fish to be introduced.
7. To plant up the large area of eroded land below the proposed lake with various types of trees (teak, *semul, gamhar, toon*, sissoo, etc.) and *sabai* and other grasses. This area is a bad example of sheet erosion, 10 or 12 feet of soil having been removed probably within the last 60 or 70 years, leaving the bare rock exposed in many places. This barren and eroded expanse is part of the site of an old palace, the ruins of which can still be seen in places. A striking illustration of the extent of the erosion is given by an ancient well, the brick lining of which now stands many feet above the surrounding land.
8. To start plantations of sissoo and other valuable timber trees at certain suitable places within the fence.
9. To carry out gully control (especially the deep gullies south of the proposed lake, which are eating into cultivated land and are up to 10 feet deep).
10. To try experiments in improving the grazing on the gently sloping land south of the hill. To try the effect of annual grass-cutting instead of grazing. To try experiments in hay-making.

11. To try various methods of contour-ridging, terracing or trenching in suitable places.
12. To plant up a small area to the west and south-west of the hill and near the proposed lake with ornamental flowering and fruit trees, and to lay out this portion of the enclosed area as a park. The trees already planted include *Jacaranda, Cassia javanica, Cassia fistula, Poinciana regia* and other flowering trees, as well as *Acacia melanoxylon, Eucalyptus, Casuarina, Pinus longifolia,* etc., *Amherstia nobilis* is being tried in good soil near the lake.

The whole area has been extremely heavily grazed, as well as ruthlessly denuded of wood, for many years, and it was considered essential to fence it for some years to give the vegetation a chance to recover and to make it possible to carry out erosion control measures. Government made a grant of Rs. 1,200 for the fencing. By far the most suitable fencing is woven wire, but the cost of this became excessive owing to the outbreak of war, and a cheaper form of fencing had to be used. The posts are sal posts well tarred. The total area enclosed by the fence is about 150 acres.

In order to finance the rest of the scheme, including planting of trees and bamboos, construction of the dam, wages of two *malis*, etc., a sum of about Rs. 2,000 was raised by subscriptions from members of the public who were interested in the scheme. It is hoped to keep a sufficiently large balance in the bank to ensure that the *malis* can continue to be paid for four or five years.

At the "Arbor Day" ceremony on the 7th July, a large number of prominent people from Hazaribagh were present and also many people from Ranchi which is 60 miles away. The writer was present, also Mr. Sabharwal, the Conservator of Forests, who has taken a keen interest in the scheme from the start, and Mrs. Sabharwal, Mr. Derry, I.F.S. and Mrs. Derry, and Mr. Chaudhri, I.F.S. Other distinguished visitors from Ranchi included several Secretaries to Government and their wives. The ground had been prepared for a large sissoo plantation and no less than 1,200 sissoo root and shoot cuttings of *Dalbergia sissoo* were supplied free of charge by the Forest Department from the nursery at Ranchi. A number of teak,

gamhar, toon and other cuttings were also kindly supplied by the Forest Department. The proceedings began with short speeches by the writer and Mr. Houlton. Sixty or more visitors including the ladies then worked vigorously at planting the trees and, just after the work was completed, there was a heavy and very auspicious shower of rain. The proceedings were concluded by a picnic lunch provided near the spot.

The Conservator of Forests hopes that "Arbor Day" will become an annual event in the Province. The interest aroused by this first celebration of the day augurs well for the future, and the Kanhari Hill Scheme, where the celebration took place, may well inspire similar schemes in many other parts of the Province.

The writer has already been able to interest the Chairman of the District Board, Hazaribagh, and some local public men. It is probable that the District Board will soon celebrate Arbor Day in certain selected areas primarily through the school children.

PRELIMINARY NOTE ON NILAMBUR SOILS WITH SPECIAL REFERENCE TO THEIR SUITABILITY FOR TEAK

BY P. W. DAVIS, I.F.S.,

(Till recently) Divisional Forest Officer, Nilambur Division

Summary.—Teak has frequently been planted in Malabar on soils bearing good quality mixed forest including fine teak with all the indications of a good site for teak, but the plantations were frequently disappointing, tending to stagnate after a time or even to be invaded by more tolerant species resulting in the replacement of the teak. The soil is of gneissic origin, and the climate, being an alternation of heavy rain and great heat and drought, presents conditions favourable for the formation of laterite *in situ* on exposure or through any act that causes reduction in the humus content of the soil. The theory of laterite formation is discussed and the author points out how the acts of clear-felling, burning and weeding on the one hand and the maintenance of a pure crop of an extreme light-demander on the other are likely to cause rapid laterisation and a change from an eminently suitable to an absolutely unsuitable soil for teak.—M. V. L.

The technique of forming teak plantations has now reached almost "foolproof" standard, so that in the teak growing districts a successful first year plantation is almost assured. The invention of the stump, planted nice and early, not only gives us teak without tears but gives us bigger and better young teak. If weedings are

properly performed, the early growth-rate is very largely just a function of the soil drainage. Even a mediocre soil, provided it possesses some organic humus and is porous and well drained, will permit quite satisfactory growth for a time.

And accordingly, since no man's reputation is risked, over-optimism in the selection of sites fit for planting with teak is apt to follow. Possibly in other divisions experience in the past decade has proved that the scope of successful planting can be extended. The object of this note is to indicate that whatever might be the case elsewhere, at elevations and in climates different from those of Nilambur, there is need for *great* caution in the selection of sites on the plains of Malabar and the West coast generally. We should in fact be more, not less, exacting in the choice of land for clearing and planting than we have been in the past.

Although it is already a well accepted fact that initial growth (for the first five years at least) gives but little indication of the true quality of the locality, there has been perhaps insufficient appreciation of just what factors begin to operate upon the site from the time the original vegetation is cleared, whether they affect the soil quality or not, or in what way.

It is appropriate to note the following figures from Mr. Brown's Working Plan of 1928:

(*i*) Area more or less successfully planted with teak	4,497.9 acres.
(*ii*) Failed teak areas included in the Teak Felling Series	394.1 ,,
(*iii*) Miscellaneous Felling Series, consisting *chiefly* of areas upon which teak was planted and failed	976.9 ,,

The total of (*ii*) and (*iii*) together is 1,371 acres, or roughly 30 per cent. of (*i*).

From a report made by the Working Plans Officer, Nilambur Division, on 20th July, 1938, upon a comparative study of first and second rotation stock-maps, it was seen that out of 586.1 acres planted, the area of failure had *increased* from 50.6 acres (first rotation) to 64.1 acres (second rotation). Improved methods do not appear to have overcome all difficulties.

It is true that the large area of "failure" in the past is partly due to administrative reasons and to causes beyond our control. Nevertheless, considering the special attention which the Nilambur plantations have had in the past (even to the extent of annual removal of undergrowth!) the proportion of failure is undeniably high. An examination of the area generally known as "Nilambur Block" (which includes Edacode, Elenjeri, Ramalur, etc.) will show where these failed areas are chiefly located. *They are mainly located upon hill-tops and more particularly upon slopes of southerly and westerly aspects.* The first quality areas are very restricted and are almost entirely to be found in narrow strips alongside river banks. We are probably quite willing to attribute to our predecessors a certain over-optimism or even lack of judgment, in the selection of sites. But it is by no means certain that our predecessors were under any illusions regarding the comparative suitability of various soils for teak, or were any less knowledgeable than we concerning the unsuitability of laterite and swamp areas. There is no warrant for such assumption. I submit that an alternative explanation for the failure of these extensive patches of teak is that many of the sites *were* good and fertile when planted, but the quality of the soil *subsequently* degraded rapidly and the teak died out.

There is further evidence for this. Apart from the areas already accepted and included in the euphemistically termed "miscellaneous" (or "m") areas, there is unfortunately a further considerable extent of what I am tempted to call the "p" areas—"pathetic" or even "pathological" plantations. In these one observes stagnation of growth, stagheadedness, heavy *Loranthus* attacks, menacing climbers and a dying off of individual trees here and there for mysterious causes (a root fungus was identified in one case). These are not signs of health. Studied dispassionately, they suggest an early demise! These signs are, as a rule, accompanied by an invasion of "junglewood" species, faster growing and more tolerant, such as *Terminalia paniculata, Xylia, Bambusa, Macaranga, Lagerstroemia, Cleistanthus* and others. The 1926 plantations in New Amarampalum Reserve (Vettikal Block) is a case in point. Mr. R. S. Browne (author of the 1928 Nilambur Working Plan) remarked of this area in a recent letter: "The soil *looked* very nice before felling but the plantation turned out miserably even within three years

after planting." The soil profile of a pit dug in this plantation (Compartment No. 381) was examined. It is seen to be *an advanced stage of laterite.* A similar soil is found in Compartment 341 (1921 plantation) nearby. It is true, not all of Vettikal Block is like this; some of it, for example Compartment 379 (1926), appears to be fairly good so far. On the other hand, a lot of it has turned to swamp. I do not myself believe that these soils were an advanced laterite or were very evidently swampy when clear-felled in 1926.

The 1926 and 1927 plantations in Nilambur Range were equally unfortunate, for there also the teak is sparse, stagheaded, dying, climbers and *Loranthus* abounding and *Xylia* and *Cleistanthus* taking possession.

Another interesting example occurs in the Erambadam 1929 Plantation (Compartment No. 394). Alongside the river bank on alluvial soil grows super-1st Quality (Nilambur) Teak. Away from the river, the ground rises gently and the crop quality correspondingly falls off gently. At the north-east corner a vigorous *Xylia* thicket has come in naturally. Many teak trees are already suppressed by it and what remain are likely to be swamped out in a very short time. The ground here is mostly *laterite rock.* Now it seems highly unlikely that this site would have been felled or planted up had the surface been *originally* hard laterite rock. Even if it were so, the plants would have died out very soon The conclusion to be drawn is that the rock has been exposed (or *formed*) since planting (*i.e.*, within the last ten years). On the other hand, it is illuminating to note that no signs exist of any corresponding deterioration in the quality of the alluvial soil near the river bank, nor are there any indications of any falling off in teak increment (the poles are found to have annual growth rings half to three-quarter inch wide), nor are they in the least endangered by other species.

Similar evidences are to be found in Panengode, Walluvassery, Edacode (especially the 1891 and 1892 Plantations) Old Amarampalam (although here plantations are nearly due for final felling) and Karimpoya (*e.g.*, 1911 Plantation).

The suspicion that a pure light-demanding crop must in some way or other cause the soil under it to lose fertility is, of course, not a new one. It is interesting to recall how the alarm was sounded some twelve years ago when difficulties were first experienced in establishing young second rotation crops in Nilambur. "The problem of the pure teak plantation" was broached at the Third Silvicultural Conference at Dehra Dun in 1929. The Conference wisely refrained from expressing any general conclusions upon the evidence then available and awaited the collection of further information on the subject by the Central Silviculturist, which was in due course published in Forest Bulletin No. 78 of 1932. The subject was again discussed in 1934 at the Fourth Silvicultural Conference. By that time the earlier scare had died down with the discovery of improved plantation technique. It was clear that absolutely no quantitative data were available to prove that any soil deterioration had taken place. Even the suggestion that an underwood should be encouraged was not supported by the Java experiments conducted by Dr. Cl. Coster which indicated that (under Java conditions) teak increment was decidedly retarded by underplanting *any* species, the most harmful being *Lantana camara* and the least harmful *Leucæna glauca,* a deep-rooted legume (*Leucæna* has 20 per cent. of its roots below 200 cms.; *Tephrosia candida* has only 6 per cent.). However, these experiments were all conducted upon fairly young crops and, in spite of the conclusions drawn from them, it was generally felt (probably on commonsense grounds) that an underwood *was* desirable under teak for soil protection. No really fresh material has since come to hand and, at the last Silvicultural Conference in 1939, after summarising the present situation, it was decided that further research was needed. *inter alia,* upon the soils themselves.

The problem which, having originated in Nilambur alluvium, seems to have got stuck in it for a long time, has recently taken a fresh turn. The areas selected by the Working Plans Officer for clear-felling and planting up with teak in the new "Periodic Block I" of the Conversion Working Circle have been located in two separate places. The first locality is for the most part flat or gently undulating and with a fairly high water-table. It seems to be

largely of an alluvial character. The second area is a watershed between two rivers, the Karimpuzha and the Kallianthodu, for the most part undulating and hilly. Mr. R. S. Browne has recently questioned the suitability of certain parts of this latter area on the ground that it was lateritic in character and too similar to the 1926 Vettikal area which has proved largely a failure. He remarked "where we can grow teak of which none is better than III quality, and a good deal is likely to be ousted by laterite-tolerating species I am doubtful about trying teak at all. . . ."

The same views were put forward by me in a note on "The efficiency of irregular stocking" submitted in 1939 for the Silvicultural Conference. I said:—"In the new Periodic Block. . . . extensive plantations will be made upon a deep red loam which at present supports a vigorous invasive crop of young *Xylia* poles, which must be sacrificed. The soil will undoubtedly support a fast-growing crop of young teak to begin with but it is difficult to believe that the same phenomenon (*i.e.*, the *Xylia*) will not reassert itself in the second half of the rotation. The combination of high rainfall, acid soil and efficient fire protection, must . . . . restore a natural forest of dense and tolerant vegetation of an uneven constitution which we shall be powerless to prevent." A photograph of the type of area to which I referred is shown in Plate 49. It has now been clear-felled.

The two types of soil in the above two localities happen to illustrate well the two contrasting sets of orographical and hydrographical conditions which it is essential to recognise for a proper appreciation of this problem.

In the elevated regions, water pours off the slopes, carrying fresh soil cover with it and also percolates down through the soil mass, carrying matter in suspension and solution; in short, matter is *removed* by water action. On the other hand, in flat alluvial areas, especially near river confluences and where the slope of river-beds flattens out, the swollen streams leave deposits—they *build* soil. Even if actual deposits no longer take place regularly on a large scale, the former deposits are there and the water table is never far below the surface. Such soils are therefore kept perpetually moist. Their particles consist of clay, silt and the finer organic and mineral

particles washed off from higher elevations, whereas the latter are left with coarser mineral débris. Again, hilly regions, having a varying aspect, present the soil surface at different degrees to the sun rays—a matter of great importance to the soil micro-climate in tropical countries, alluvial soils, being flat, are all the same. On hillsides, soil *profiles* develop; in alluvial soils profiles are generally absent. Soils subject to rapid percolation and leaching are dynamic in character. Raw alluvial soils with little percolation, powerful holders of moisture and undergoing comparatively small changes of moisture content, are *adynamic* or, perhaps, a more correct term for them is "*pseudoadynamic*" (since they are not, of themselves, incapable of any change, but the conditions of their existence do not contribute towards rapid changes in constitution).

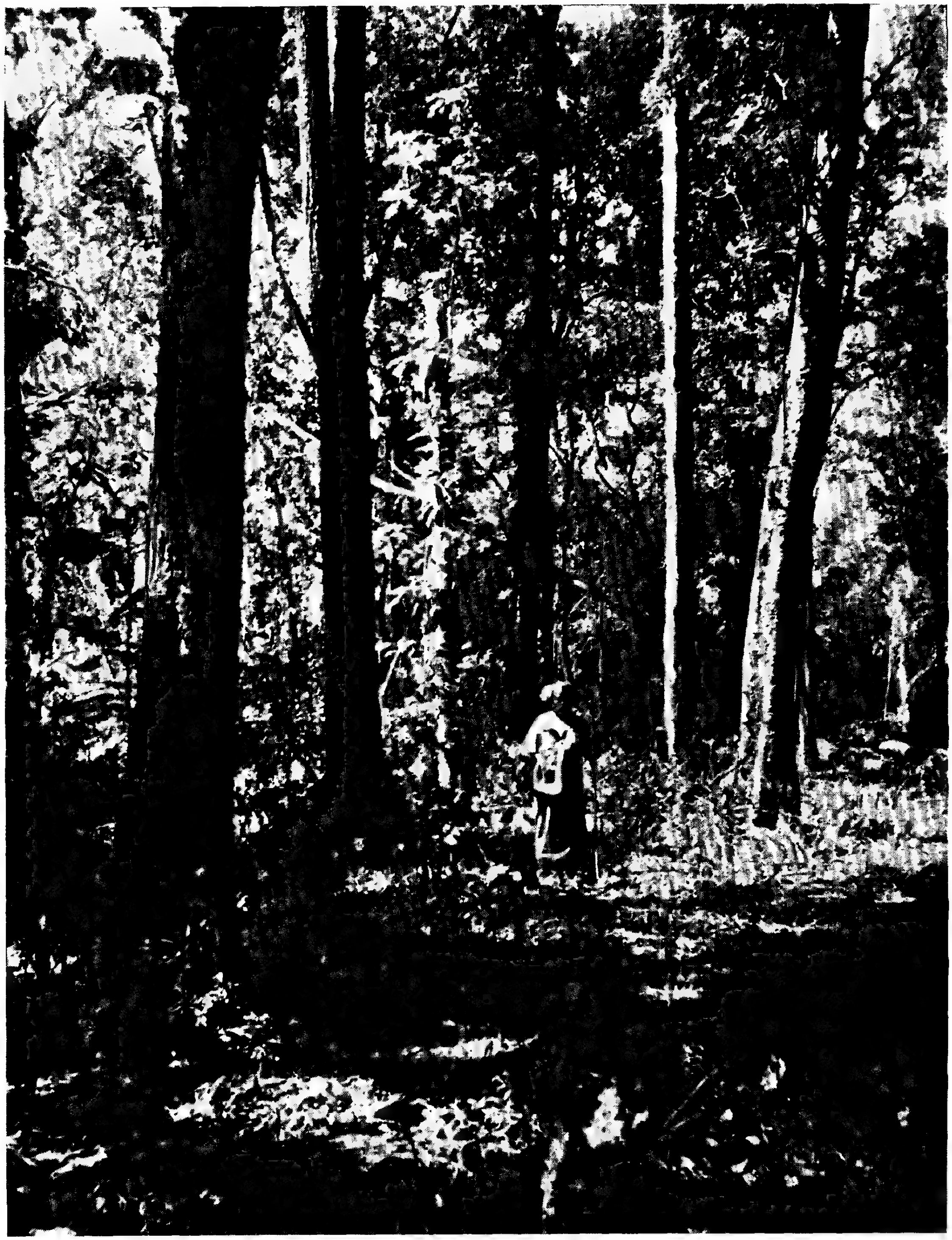
This idea, *viz*., that the principal regulator of the dynamic phenomena contributing to soil formation is the degree of humidity prevailing in the soil, is the leading one in Glinka's system of soil classification.

If this is accepted, then in no country in the world is the rôle of water as a soil-forming factor more important and fundamental than in Malabar, with its alternating extremes of intense precipitation and intense drought (modified only by a coastal atmosphere).

A fact of first importance, therefore, emerges, viz., *that whereas soil conditions on or near river banks and at low relief are more or less stable, well-drained zones away from rivers are relatively, indeed exceedingly, unstable.* (I refer to Malabar in particular.) This explains at once the *immediate* change to lateritic conditions which are so often seen to accompany even a very slight increase in elevation away from a watercourse.

It would follow from this that, while it has been possible successfully to carry on our teak planting into a second rotation upon riverain areas in the region of Nilambur (which is nearly all alluvial silt), it by no means follows that the same will be the case upon excessively drained soils formed by the weathering of rocks *in situ* in various parts of Amarampalam Range, even if it be possible to reach the end of the first rotation!

Mixed crop of *Terminalia paniculata* and *Xylia xylocarpa* poles. Clear-felled in 1938, planted with teak in 1939. Site is elevated and soil a fairly deep red loam having gravelly laterite accretions but with considerable penetration of organic material.



Mixed deciduous forest adjoining stream bank. Large trees of *Dillenia pentagyna* (left), *Terminalia tomentosa*, teak (behind figure) and *Xylia xylocarpa* (right). Note absence of *Xylia* poles and sparse undergrowth. Soil is alluvial, with no sesquioxide accumulation layer. Considered suitable for teak planting.

Here it might be worth mentioning that *our 1st Quality Teak all appears to be situated on apparently undifferentiated and profile-less soils—vide Plate 50.*

But very good straight and well grown natural teak is found scattered by ones and twos in the excellent deciduous crop found at Kanhirakadavu upon the "doubtful" area under discussion. The height growth is excellent. Apart from the fact that certain limited parts of this region are chiefly under *Xylia* crops, is there any reason to suppose that the locality will not continue to support an excellent teak crop if planted and exactly what changes, if any, will the soil undergo under teak?

In the first place, information, at the time of writing this note, is rather lacking upon the precise kinds of soil we are initially dealing with in every instance. Some, situated on a north or north-east aspect, would *seem* to be not unlike certain types of "Brown Earths;" raw humus is absent, but there is a topmost layer of dirty, brown, mild humus, crumbly or granular, passing through a rather heavy, brown, clayey sand into a coarser and looser lower horizon overlying parent rock. There are no obvious eluvial or illuvial horizons, but the uppermost horizon would appear to be the accumulation zone, if any. The subsoil is almost certainly lime-free. The brown colour is probably due to iron hydroxide and not to humus. Nevertheless, there is a considerable quantity of mild and intimate humus, which not only overlays the surface but is taken to some depths along root systems and by infiltration. There are no *obvious* signs of laterisation in these soils of cool sheltered aspects.

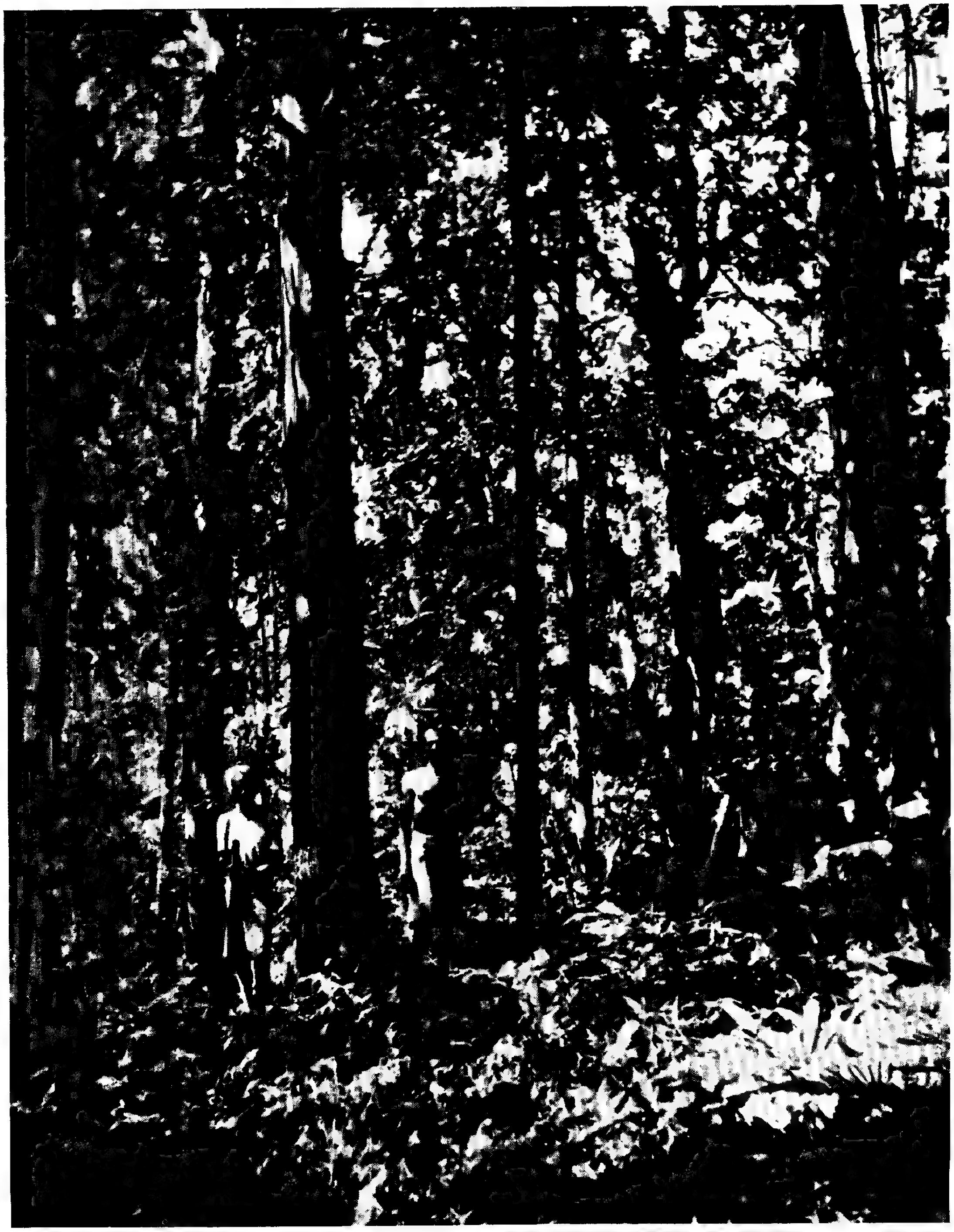
But certain other pits dug on the top of the ridge and on south or south-west aspects present a distinctly different appearance (*see* Plate 51). They are brick-red in general colour, decidedly darker in the upper layers, somewhat mottled with yellow or grey-black or streaked wih white or pale yellow sandy or crystalline material at depths below three feet. There are two other principal features common to them. First is their general plastic or cheesy consistency when fresh and moist; second is the heavy layer or dark—almost black—clayey humus loam in the surface horizon and the obvious penetration of intimate humus to considerable depths along

root systems and by infiltration in various ways. I would make a guess and class them as siallitic laterites in a somewhat precarious state of equilibrium due to the intense penetration of humus colloids in the surface layers, and to the forest cover. That they are *now* of excellent depth and fertility is seen by the high-class timber crops they carry.

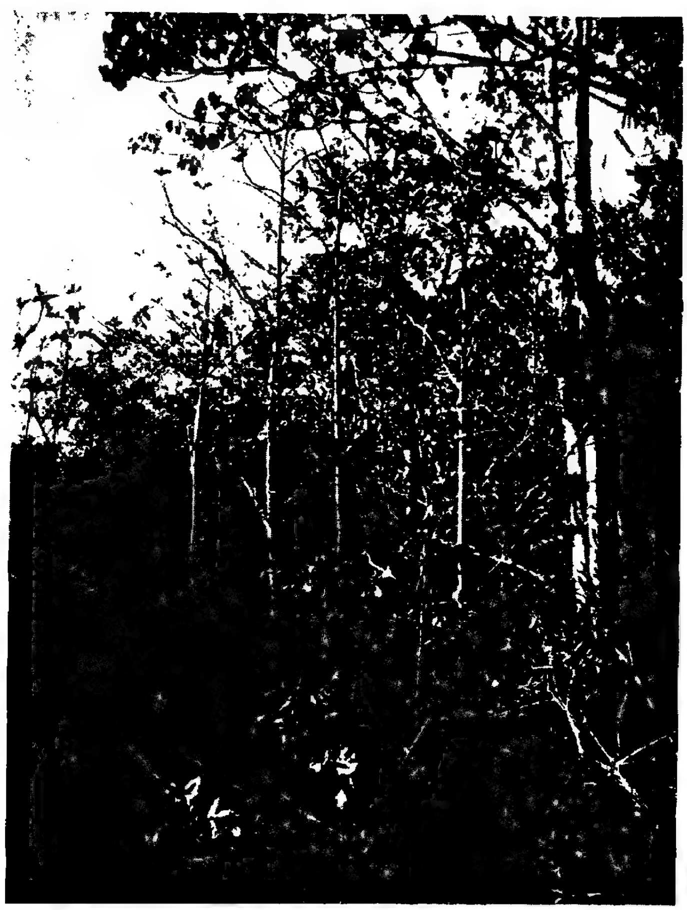
Now I would draw attention to the soil pit dug in the adjoining coupe felled in 1938, where the débris was burnt and the area planted with teak in 1939. The surface has thus been exposed for about 18 months. There are two main *visual* differences. Firstly, there is no longer visible the intimate penetration of the dark-coloured organic humus elements to depths of three feet or more. Secondly, the horizon below the surface is *gravelly,* loosely-cemented together into a porous mass by some final mineral clayey elements. Below the gravel layer we find the "cheesy" kind of horizon found in the previous group. Here the first-year growth of teak has been excellent, averaging about six feet.

Turning next to Compartment 381 of Vettikal Block west of Kanhirakadava, planted in 1926 and referred to by Mr. Browne, we see a profile *distinctly similar* in morphological characteristics, viz., a topmost greyish black layer overlying a red gravel overlying in turn a brick-red clay. The gravel, however, is definitely more "advanced" (i.e., more stony) and there is distinctly less clayey material admixed with it than in the previous example. In fact, there is an almost complete absence of fine material. On this site the teak is dying out and its place is being taken by other species (vide Figs. 1 and 2, Plate 52).

It is not correct from these few, somewhat subjective, observations to draw any general conclusions. Many more pits, accompanied by analytical data from the laboratory, properly interpreted for us, are required. I am content to indicate certain general relationships of a rough-and-ready character and to suggest certain trends. The study of the soil in the field can impart certain very essential information which is not available to the man in the laboratory, dealing with a "dead" soil. The real soil is a dynamic entity and the forest officer, by constant, careful observation and comparison can, I believe, draw sound conclusions upon profile



Excellent mixed deciduous forest on lower slopes. Species, teak, *Terminalia paniculata, Lagerstroemia lanceolata, Xylia xylocarpa.* Teak in pure plantation will grow well here for a time but may go back after 20—30 years.



Figs. (1) and (2): Vettikal teak plantation on well elevated site. Teak is stagnating and giving place to other species. Soil is a gravelly laterite, loosely cemented, with finer mineral clayey elements but lacking any considerable penetration of humus.

study *in the field* independently of the laboratory. On the other hand, laboratory data, *unless* they are carefully correlated and interpreted, will yield little practical information of value. Laboratory and field observations should, of course, supplement each other.

Some attempt must now be made to describe the theory of laterite formation. There are three things which characterise the formation of a true "matured" laterite, viz., (*i*) a leaching process, (*ii*) a silicate decomposition process and (*iii*) a sesquioxide accumulation process. For the achievement of this a tropical monsoon climate is necessary. Heat, moisture and drought all play essential parts. In the ultimate stage, laterite weathering is a dry season phenomenon. For this reason, *aspect* is a factor of very great importance.

First in the wet season, there occurs a prevalent downward leaching action which removes the bases and alkaline earths almost completely from the original elements. Owing to the high temperature of the tropics there is also an intense decomposition of the original alumino-silicates, so that the silicic acid (SiO_2) is separated from the Al_2O_3 which remains as an insoluble hydrate, the SiO_2 being also leached out. This silicate weathering proceeds to considerable depths—a process aided by the alkaline solutions—so that in *perpetually moist* zones we find a purely "allitic" layer above the parent rock which, while it retains somewhat the structure of the original rock, contains principally sesquioxides, unaccompanied by silicic acid. This substance is sometimes known as "primary" or "high-level" laterite. Now, in localities subject not only to excessively moist conditions but to a dry season following on the wet season, surface evaporation causes a converse *upward migration of solutions rich in sesquioxides.* This causes an *accumulation zone* near the surface, rich in Fe_2O_3. These, especially if they be under forest, may be nothing more than plastic siallitic laterites with high clay fractions. The humus, when present, as it is in good natural forest, also seems to serve as a "protective" colloid to the sesquioxides, keeping them in solution. But if the humus sol is removed and the sesquioxides (chiefly of iron) reach the surface, they precipitate and form a hard ferruginous crust and the soil is transformed into dead rock which (as everybody knows) is inimical to any form

of vegetation. The action of the humus substances has probably not been fully worked out. It is a matter of colloidal physics which need not be dealt with here.

Between the purely allitic, intensely leached "primary laterite" of the very moist *ghat* regions having a well distributed rainfall throughout most of the year, to the "matured" lateritic ironstone of the regions of hot weather drought, there are many intermediate stages. In regions of lower rainfall, the decomposition processes are never quite so intense in the first instance, so that the product is probably only secondary silicious compounds together with alumina and iron oxides—the so-called "siallitic" earths, there are also siallitic clays, which are generally highly plastic, cheese-like in consistency. The "gravelly laterite" which is so commonly come across, seems to be a penultimate stage in the concretionary accumulation process. The impression I have gained by observation is that the penultimate and final stages in the process of laterite ironstone formation may occur with comparative rapidity. *If the above general theory (attributed to Harrassowitz) is true—and it seems to be borne out by observation in Malabar—the retention of every available particle of cover, both vegetational and humus, over such soils, is of the very greatest importance in the retention of fertility and ought indeed to govern our whole land policy.* Laterite rock is not a kind of weathered outcrop of "rock" which has become disclosed by the washing off of a top layer of mud, but it is the last stage in a very complex process of weathering in the *soil itself.* Laterite rock is simply and literally petrified earth. The process, unfortunately, appears to be irreversible. It is certainly proceeding rapidly over large areas in Malabar.

We can now visualise more clearly the effect which clear-felling natural forest, burning the débris and planting with a species such as teak has upon soils the levels of which are high above the natural water table.

The soil under natural forest, with its several layers of leaf canopy and fairly rapid humus formation (although there might be no actual *accumulation* of humus) is kept in the first place comparatively cool and moist. The oxidation of humus is retarded. This obviously reduces surface evaporation. The roots of trees of various

sizes and species penetrate to different layers; the decay of various parts of root systems causes a constant and intimate penetration of organic humus material to considerable depths. Moisture, moreover, is drawn by the roots not only from the topmost layer but from various layers at depth. The soil is kept porous, increasing the amount of percolation and decreasing the amount of wash-off. All these factors serve, as indicated earlier in this note, to retain the soil in a state of fertile equilibrium, in spite of the adverse climatic factors which tend to cause deterioration. The importance of tree cover is the more urgent upon "hot" slopes of southerly and south-westerly aspects.

The process of forming teak plantations is, unfortunately, inseparable from insolation. Clear-felling and burning destroys leaf-cover and oxidises the surface humus mulch. Root systems are destroyed. Surface evaporation is greatly increased. There is increased wash-off during the rains carrying away more humus. Teak is planted. But teak, unfortunately, is a light-demander and intolerant of competition. The ground has to be scraped and cleared of vegetation during weedings. Teak loses all its leaves in the dry weather and seems to add nothing to the soil, therefore, the process of humus oxidation goes on year after year. Moreover, teak roots do not penetrate the soil to the same depths as do the trees of the natural forest, for primarily it is a surface rooter; consequently, the rest of the soil tends to become more compact and also to lose, once and for all, those colloidal gels which inhibit the precipitation of sesquioxides from solution. In short, the insolation of the soil consequent upon growing teak must seriously deplete the soil of those humus silicate gels which serve to prevent concretionary laterite formation. Not only that but the soil gradually loses its power of moisture retention so that the effective teak growing season becomes shorter. Stagnation of growth follows, sooner or later, and all the other familiar signs previously described.

In its place, more tolerant and more xerophytic species come in. *Xylia in particular is a laterite-loving species and if it can become established on such sites before the final surface "rock" stage is reached, it is a species to encourage, as also are all other shade-bearing or thick-leaved or evergreen or laterite-tolerating species to*

cover the ground and replenish the deficient humus cover before it is too late.

A "3rd quality soil" in Nilambur cannot be compared with a soil in drier districts supporting a crop corresponding to "Nilambur 3rd quality." In the latter, teak may be a natural and stable crop; it will grow as well, if not better than, many other species. On Nilambur laterites that is not the case. If teak quality starts to fall off, the chances are that other species will come in and take its place, because they grow faster and better than the teak.

I deliberately exclude from this discussion plantations upon Nilambur alluvium; as already pointed out, these are relatively stable, and even upon rather poor alluvial soils, teak will grow as readily as most other species, provided the ground is not swampy. Nevertheless, it is of interest to note that stump analysis as well as yield curves show unmistakably that teak increment during first rotation is extremely rapid for the first 15 years or so but thereafter increments drop off *very considerably* during the whole middle life of the plantation. At Nalluvassery on 2nd quality alluvial soils (Compartments 159 and 160) increment got a boost again after about the 55th year. It is not impossible that soil deterioration in the first half of the rotation, consequent upon insolation, thinnings, etc., may be the cause of this depression of increment after the initial burst of rapid growth is over, and that only after an underwood has to some extent rehabilitated the soil, does teak "start to grow" again at the latter end of the rotation. It is interesting also to note that between 1863 and 1906 all or most of the undergrowth was annually or periodically cleared. Some caution is necessary here, however, for other factors, especially thinnings, have influenced growth; past thinnings, by modern standards, were far too conservative.

From the foregoing arguments I feel bound to conclude that before going ahead to clear-fell large areas of deciduous forest in so-called "disintegrated gneiss" soils (gneissic boulders on the surface, be it noted, are no criterion that the soil is not lateritic beneath), we ought to take time for close, scientific observation on well-planned lines. There are still ample areas where teak planting is quite suitable, and these require no careful search to find. The

presence of individual teak trees or small groups of teak in the midst of a natural forest of other species does not, *ipso facto,* warrant the assumption that it is advisable *in Malabar* to grow teak in a plantation. Mere height growth also is no indication that teak will thrive in pure plantations. Soils which are very fine deep and fertile soils under certain conditions of equilibrium are capable of deteriorating *very rapidly* to laterite under certain other conditions. Personally I should feel inclined to beware of soils showing any distinct "profile," especially on hot slopes.

A text-book maxim which needs to be borne in mind is: "*A forester's first duty is to maintain and improve the fertility of the soil.*" In no part of the world is it more necessary to remember this than in Malabar.

KARNPUR AND BINDRABAN BAMBOO FORESTS (ADDENDUM AND CORRIGENDUM)

ARTICLE PUBLISHED IN THE *Indian Forester* IN ITS ISSUES FOR MAY AND JUNE, 1940.

BY MIAN SAEED AHMAD,

E.A.C. Forests, Andamans.

JUNE ISSUE

(1) In remarks column of the statement on page 358, *below* "Karnpur @ -/-/10 per tinful," *add*: "and in Bindraban @ -/1/3 per tinful."

(2) *Below* the statement on page 362, *read* the following note: "Fashioning rate of Chhar II was increased to Rs. 3/- per cent. in 1937-38."

(3) On page 363, in 4th line from top, *read*: "pies" *instead of* "annas."

(4) In the end of the whole note, *read* the following as *additional paragraphs*:

"The distribution of the output of bamboos from these forests to the various markets in the Punjab and N.W.F.P. will be interesting for a study of the variations in demand from place to place.

The statement below is compiled both from official figures and from figures of the bamboo dealers, and gives the total quantities of these bamboos put up for sale by them in their respective districts, during the years 1935-36 to 1938-39:

Serial No.	Name of the District	TOTAL BAMBOOS PUT UP FOR SALE, ETC.				REMARKS.
		1935-36	1936-37	1937-38	1938-39	
1	Lahore ..	79,371	138,127	106,094	214,836	(a) 1935-36 and 1938-39 are sales by auction.
2	Hoshiarpur ..	108,783	130,228	118,440	141,205	
3	Jullundur ..	65,695	129,935	143,950	117,794	
4	Amritsar ..	3,000	10,100	118,100	46,217	
5	Lyallpur ..	36,610	5,400	1,000	..	(b) 1936-37 and 1937-38 are sales by canvassing of the writer in the different markets.
6	Sialkot ..	..	13,000	7,250	2,550	
7	Peshawar ..	..	7,000	13,000	..	
8	Gujranwala ..	..	2,675	6,900	..	
9	Kapurthala ..	10,000	..	5,000	1,000	
10	Ferozepur ..	..	..	2,900	..	
11	Ludhiana ..	52	..	625	..	
12	Muzaffargarh ..	249	..	..	..	(c) Official supplies to right-holders included against Hoshiarpur District.
13	Multan ..	48	..	1,850		
14	Gujrat ..	..	1,500	500	..	
15	Gurdaspur ..	..	722	..	..	
16	Rawalpindi ..	..	400	..	800	
17	Montgomery ..	..	..	1,600	..	

TIMBER PRICE LIST FOR SEPTEMBER-OCTOBER, 1940
(INDIAN STATES)
(ISSUED MONTHLY BY THE FOREST RESEARCH INSTITUTE).

Trade or common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Baing	*Tetrameles nudiflora*	Cochin	Logs	Re. 0-6-2 per c. ft.
„	„	Travancore	Logs	Re. 0-10-0 per c.ft.
Benteak	*Lagerstrœmia lanceolata*	Cochin	Logs	Rs. 1-1-3 per c.ft.
„	„	Mysore	Logs	Re. 0-13-6 per c. ft.
„	„	Travancore	Logs	Re. 0-12-4 per c.ft.
Bijasal	*Pterocarpus marsupium*	Barwani	Logs	
„	„	Cochin	Logs	
„	„	Dhar	Logs	
„	„	Hyderabad	Logs	Re. 0-12-0 to 1-0-0 per c.ft.
„	„	Indore	Beams 14′ × 18″	Re. 0-8-0 per c.ft.
„	„	Mysore	Logs	Rs. 1-8-8 per c.ft.
„	„	Patna	Logs	Re. 0-8-0 to 0-12-0 per c.ft.
„	„	Travancore	Logs	Rs. 1-1-0 per c.ft.
Deodar	*Cedrus deodara*	Patiala	Sleepers 10′ × 10″ × 5″	Rs. 7-4-0 each.
Dhupa	*Vateria indica*	Cochin	Logs	Re. 0-11-0 per c.ft.
Gamari	*Gmelina arborea*	Tripura	Logs	Rs. 1-0-0 to 1-8-0 per c.ft.
Gurjan	*Dipterocarpus* spp.	Cochin	Logs	Re. 0-9-0 to 0-11-0 per c ft.
„	„	Tripura	Logs	Rs. 1-0-0 per c.ft.
Haldu	*Adina cordifolia*	Barwani	Logs	
„	„	Bansda	Logs	
„	„	Banswara	Logs	Rs. 1-2-0 to 9-0-0 per log.
„	„	Bhopal	Logs	Re. 0-7-0 to 0-9-0 per c. ft.
„	„	Cochin	Logs	
„		Dhar	Logs	
„	„	Mysore	Logs	Re. 0-12-2 per c.ft.
„	„	Patna	Logs	Re. 0-6-0 to 0-8-0 per c.ft.
„	„	Travancore	Logs	Re. 0-14-4 per c.ft.
Hopea	*Hopea parviflora*	Cochin	Logs	Rs. 0-15-9 to 1-8-8 per c.ft.
„	„	Travancore	Logs	Rs 1-0-0 per c.ft.
Indian Rosewood	*Dalbergia latifolia*	Barwani	Logs	
„	„	Bansda	Logs	
„	„	Cochin	Logs	Rs. 1-2-6 to 1-11-1 per c.ft.
„	„	Dhar	Logs	
„	„	Kishengarh	Logs	
„	„	Mysore	Logs	Rs. 2-8-2 per c.ft.
„	„	Patna	Logs	Re. 0-8-0 to 0-12-0 per c.ft
„	„	Travancore	Logs	Re. 0-7-9 to 1-3-6 per c.ft.

Trade or common name.	Species.	Locality.	Description of timber.	Prices.
1	2	3	4	5
Irul ..	*Xylia xylocarpa* ..	Cochin ..	Logs	Re. 0-12-4 to 1-8-8 per c.ft.
,, ..	,, ..	Travancore ..	Logs ..	Re. 0-12-10 per c.ft.
Kindal ..	*Terminalia paniculata* ..	Cochin ..	Logs ..	Re. 1-3-8 per c.ft.
,, ..	,, ..	Mysore ..	Logs ..	Re. 0-9-1 per c.ft.
,, ..	,, ..	Travancore ..	Logs ..	Re. 0-9-10 per c.ft.
Laurel ..	*Terminalia tomentosa* ..	Barwani ..	Logs ..	
,, ..	,, ..	Bansda ..	Logs & squares	
,, ..	,, ..	Bhopal ..	Logs ..	Re. 0-12-0 to 1-0-0 per c.ft.
,, ..	,, ..	Cochin ..	Logs ..	Re. 1-1-3 per c.ft.
,, ..	,, ..	Hyderabad ..	Logs ..	Re. 0-10-0 to 1-0-0 per c.ft.
,, ..	,, ..	Indore ..	Sawn material.	Re. 1-4-0 per c.ft.
,, ..	,, ..	Mysore ..	Logs ..	Re. 0-10-5 per c.ft.
,, ..	,, ..	Patna ..	Logs ..	Re. 0-6-0 to 0-10-0 per c.ft.
,, ..	,, ..	Travancore ..	Logs ..	Re. 0-14-1 per c.ft.
Mesua ..	*Mesua ferrea* ..	Cochin ..		
,, ..	,, ..	Tripura ..	Logs ..	Rs. 1-8-0 to 2-0-0 per c.ft.
Sal ..	*Shorea robusta* ..	Cooch Behar	Logs & scantlings	
,, ..	,, ..	Patna ..	Logs ..	Re. 0-8-0 to 0-12-0 per c.ft.
,, ..	,, ..	Tripura ..	Logs ..	Re. 1-0-0 to 1-4-0 per c.ft.
Sandan ..	*Ougeinia dalbergioides* ..	Bansda ..	Logs ..	
,, ..	,, ..	Patna ..	Logs ..	Re. 0-8-0 to 0-12-0 per c.ft.
Semul ..	*Bombax malabaricum* ..	Banswara ..		
,, ..	,, ..	Cochin ..	Logs ..	Re. 0-6-2 per c.ft.
,, ..	,, ..	Cooch Behar	Logs & scantlings	
,,	,, ..	Rampur ..	Planks 6′×1′×1¼″ ..	
,, ..	,, ..	Travancore ..	Logs ..	Re. 0-10-0 per c.ft.
,, ..	,, ..	Tripura ..	Logs ..	Re. 0-4-0 to 0-5-0 per c.ft.
Sissoo ..	*Dalbergia sissoo* ..	Banswara ..		
,, ..	,, ..	Cooch Behar	Logs & scantlings	
,, ..	,, ..	Hyderabad ..	Logs ..	
,, ..	,, ..	Rampur ..	Planks 6′×1′×1¼″ ..	
Teak ..	*Tectona grandis* ..	Barwani ..	Logs ..	
,, ..	,, ..	Bansda ..	Logs ..	
,, ..	,, ..	Banswara ..	Logs ..	Rs. 1-4-0 to 3-8-0 per log.
,, ..	,, ..	Bhopal ..	Logs ..	Rs. 1-0-0 to 1-10-0 per c.ft.
,, ..	,, ..	Cochin ..	Logs ..	Re. 1-4-0 to 3-0-0 per c.ft.
,, ..	,, ..	Indore ..	Sawn material	Re. 0-15-0 to 1-4-0 per c.ft.
,, ..	,, ..	Mysore ..	Logs ..	Rs. 2-10-10 per c.ft.
,, ..	,, ..	Travancore ..	Logs ..	Re. 0-11-3 to 2-0-8 per c.ft.

EXTRACTS

REPORT ON TRIALS MADE IN THE UNITED PROVINCES WITH CERTAIN SOUTH AFRICAN AND INDIGENOUS FODDER GRASSES

By E. W. Raynor, I.F.S.,
Silviculturist, U. P.

[EXTRACT FROM THE ANNUAL RESEARCH REPORT OF THE SILVICULTURE DIVISON, U.P., FOR THE YEAR 1939-1940]

Experimental propagation of various indigenous (Afforestation Division) and exotic (S. African and American) fodder grasses was

continued at Clutterbuckganj and two new grass experiments were started in Bahraich and Saharanpur Divisions, with the object of ascertaining suitable methods of introduction of good fodder grasses into forest plantations.

The following South African species have been tried during 1937, 1938 and 1939:

(1) *Acroceros macrum.*
(2) Antelope.
(3) *Digitaria peutzii.*
(4) *Digitaria seriata.*
(5) *Digitaria swasilandensis* strain.
(6) *Panicum maximum* (Guinea grass).
(7) *Panicum phragmatoides.*
(8) *Setaria du toitskraal* strain.
(9) *Kikyu.*

The following tables show the results of comparative weighments on harvesting the species which succeeded *in nursery conditions*:

TABLE "A"

Species		Average Sample Yield (per acre) (Harvested in October/November, 1939) Green	After 10 days' driage	
		Mds.	Mds.	
Sown in 1937 and 1938.	*Digitaria peutzii* ..	218	127	All watered on dry days as necessary.
	Digitaria seriata (stapf) ..	133	71	
	Digitaria swasilandensis strain	125	83	
	Panicum maximum ..	167	82	
	Panicum phragmatoides ..	183	88	
	Setaria du toitskraal strain ..	123	57	

TABLE "B"

Transplanted in 1937 and 1938.	*Acroceros macrum* ..	91	53	All watered on dry days as necessary.
	Antelope ..	59	45	
	Digitaria peutzii ..	144	65	
	Digitaria seriata ..	106	55	

TABLE "C"

	Species.	Average Sample Yield (per acre) (Harvested in October/November, 1939)			
		Watered (on dry days)		*Non-watered*	
		Green	After 10 days' driage	Green	After 10 days' driage
		Mds.	Mds.	Mds.	Mds.
Sown in 1939.	*Digitaria peutzii* ..	54	28	14	9
	Panicum maximum ..	285	149	183	95

TABLE "D"

Trans-planted in 1939	*Digitaria peutzii* ..	82	37	42	26
	Digitaria seriata (stapf)	85	33	45	20
	Digitaria swasilandensis strain ..	127	44	71	33
	Panicum phragmatoides	130	47	55	28
	Setaria du toitskraal strain ..	91	31	72	27

For intensive cultivation in agricultural (nursery) conditions, the method of sowings followed was to mix the seed with a little fine earth or sand and to sow it in drills 1/8 inch deep and one foot apart, transverse to the seed-beds. The concentration of seed used varied from six to eight seers per acre.

For transplanting in similar conditions, rootstocks 2 to 4 inches in diameter were used and planted up at an espacement of one foot in lines two feet apart.

The only trials of S. African grasses in forest plantation conditions (as differing from intensive cultivation in nursery conditions) were those conducted in the forest taungya plantations at Clutterbuckganj, and in Saharanpur and Bahraich Divisions, where the results have been far from encouraging. In the Clutterbuckganj,

Bahraich and Saharanpur tests, the growth and stocking are very poor as compared with the results in intensive agricultural (*i.e.*, nursery) conditions, so much so in fact that it was decided not to attempt harvesting and comparative weighments at Clutterbuckganj and in the Saharanpur experiment. Only one species (*Panicum maximum* or Guinea grass) succeeded in the Bahraich tests for which the weighment data on harvesting in December, 1939, is as follows:

TABLE "E"

Species	Condition	Yield per acre (December, 1939)			
		Sown		*Planted*	
		Weeded	*Unweeded*	*Weeded*	*Unweeded*
		Mds.	Mds.	Mds.	Mds.
Panicum maximum	Green	9·7	14·0	17·8	13·3
	After 10 days' driage	4·0	5·9	7·7	6·3

The anomalous higher yield for unweeded sowings is presumed due to erroneous weeding of the cultivated grass due to non-recognition in the early stages.

All these yields are very poor, however, as compared with those in agricultural conditions, vide Tables "A"—"D" above.

The methods of sowings tried at the break of rains in forest plantation conditions were:

(*i*) Broadcast sowings (lightly covered) on longitudinal strips three feet wide, between the tree lines, in which the soil had been worked in advance (Clutterbuckganj).

(*ii*) Broadcast sowings (lightly covered) on longitudinal ridges about four to six inches high between the tree lines, after one ploughing (Bahraich and Saharanpur).

No. (*ii*) appears to be the better method, since weeding is easier and seed less likely to be waterlogged or washed away by heavy rainfall. In both cases the concentration of seed was 9—11 seers per acre, but in view of the poor results to date, 15 seers per acre is suggested for further trials.

For planting the grasses in forest plantation conditions, root-stocks about 1½ to two inches in diameter (with heads cut and roots intact) were employed, and planted during the monsoon rains at an espacement of two inches, mainly without preliminary soil working. This method has the advantages of simplifying weeding and avoiding difficulty in recognition of the cultivated grasses in the early stages.

The results of both sowings and plantings in forest plantation conditions indicate that heavy shade is a strongly adverse factor and that the only success to be hoped for will be in plantations of tree species affording only a light cover. It is also clear that without intensive early weedings, no success whatever can be hoped for.

TENTATIVE CONCLUSIONS

(Regarding South African Exotics.)

While results to date are quite favourable as regards *intensive* propagation and culture in cultivated nursery (*i.e.*, agricultural field crop) conditions, experience seems to indicate that South African exotics are not likely to maintain themselves easily *in forest plantation conditions* against indigenous weed grasses, even with intensive rains weedings in the first year. Unless the exotic grasses show themselves as capable of quick acclimatization and of becoming weeds themselves (and there is no sign of this at present), it is not advisable to attempt their large-scale introduction between three lines in forest plantations in view of the extreme difficulty and high costs of the intensive weedings involved.

The best results in nursery conditions were obtained with *Panicum maximum* (Guinea grass) and *Digitaria peutzii* and the other species also gave quite favourable results. *In nursery conditions,* where watering was found advantageous, the grasses succeeded in establishing themselves in one year and practically no weedings were required in the second monsoon. In *forest plantation* conditions the only promising species seem to be *Panicum maximum* (Guinea grass), whose progress in Saharanpur and Bahraich Divisions seems less disappointing, and *Digitaria swasilandensis,* whose

quick-spreading habit in nursery conditions is also appearing under less intensive cultural conditions.

Kikyu grass was tried twice by the Divisional Staff in forest plantation conditions in Saharanpur Division and failed on each occasion. It started well on sandy soil (70 per cent. success reported) but was attacked by termites and failed in spite of preliminary soil working and intensive weedings.

The results obtained with indigenous fodder grasses in nursery (*i.e.*, agricultural field crop) conditions by similar methods as adopted for the exotic grasses at Clutterbuckganj are tabulated below:

TABLE "A"

Sown in	Species		Average Sample Yield (per acre) Harvested in October/November, 1939: Green	Average Sample Yield (per acre) Harvested in October/November, 1939: After 10 days' driage	
			Mds.	Mds.	
1937 and 1938.	*Musel* (*Iseilema laxum*)	U. P. Grasses.	113	64	All watered on dry days as necessary.
	Bhanjura (*Apluda aristata*)		237	149	
	Anjana (*Pennisetum ciliare*)		167	95	
	Choti jergi (*Andropogon pertusus*) (*Bothriochloa pertusa*)		199	112	
	Bara jerga (*Dichanthium annulatum*)		243	130	
	Sanwan dhunia (*Echinochloa colonum*)		Failed		
	Dab (*Eragrostis cynosuroides*)		69	47	
	Digitaria adscendens	(South Indian origins)	127	80	
	Digitaria ternata		50	27	
	Sudan (*Sorghum sudanense*) (Kheri origin)	..	179	67	

TABLE "B"

Sown in	Species		Average Sample Yield (per acre) Harvested in October/November, 1939			
			Watered (on dry days)		*Non-watered*	
			Green	After 10 days' driage	Green	After 10 days' driage
			Mds.	Mds.	Mds.	Mds.
1939	*Musel* (*Iseilema laxum*)	U. P. Grasses.	206	112	143	82
	Bhanjura (*Apluda aristata*)		260	148	243	143
	Anjana (*Pennisetum ciliare*)		438	208	299	143
	Choti jergi (*Andropogon pertusus*) (*Bothriochloa pertusus*)		234	118	155	75
	Bara jerga (*Dichanthium annulatum*)		341	192	302	165
	Sanwan dhunia (*Echinochloa colonum*)		12	10	3	2
	Dab (*Eragrostis cynosuroides*)		162	105	113	76
	Sandhaur (*Bothriochloa intermedia*)		352	204	318	204
	Digitaria adscendens (South Indian origins)		37	21	38	19
	Digitaria ternata (South Indian origins)		238	113	144	101
	Sudan (*Sorghum sudanense*) (Kheri origin)		279*	113*	292*	115*

* Period of growth was mainly the rains of 1939, hence difference between watered and non-watered treatments is not very distinct. Difference may become more marked in second year.

Owing to scanty and badly distributed rainfall in 1939, the growth of various species of indigenous grasses sown and planted in forest plantation conditions at Clutterbuckganj and in the Bahraich and Saharanpur experiments under differential treatment as regards weeding and non-weeding was not so good as expected. The grasses are persisting, however, in most cases and marked progress is expected in the rains of 1940, especially under the weeding régimes. It appears likely that establishment cannot be expected without at least two years' intensive weedings.

GENERAL CONCLUSIONS

The results obtained with indigenous grasses are strikingly better on the whole than those obtained with exotics in similar conditions. The writer observes also that the indigenous species of grasses exhibit more marked promise of quickly establishing themselves and spreading in forest plantation (*i.e.*, non-agricultural) conditions, than the exotics. This was particularly observed in the case of *bhanjura* (*Apluda aristata*).

Of all the indigenous grasses, *musel* (*Iseilema laxum*) is known to be an excellent fodder grass and merits attention.

Of the exotic (South African) grasses, *Digitaria swasilandensis* strain is most striking as regards its quick-spreading habit (in nursery conditions). If this characteristic is also markedly displayed in forest plantation conditions, this luscious and turflike grass should prove extremely valuable in improving forest pasturage. Although no success was obtained in 1939 even in nursery conditions with grass seeds obtained from the U.S.A., it is since found that as a result of delayed germination which has apparently occurred in the cold season, over 25 per cent. success has been obtained with two out of three U.S.A. species tried.

FUTURE WORK

The experiments are being continued with special reference to trials of both Indian and exotic fodder grasses in forest plantation (field) conditions, under less intensive cultural treatment, and seed is collected as it ripens from all grasses under nursery treatment.

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TRUE SYMBIOSIS IN THE HILLS

The Relationship between Man, Cattle, Government and the Land

BY H. M. GLOVER

I wonder how many of us foresters have any true conception of the manner of life in the hills. Few English, as they come from flat country: fewer Scots, as their eyes are fixed on England and on the rich cities of the east; still fewer Indians as they mostly come from the plains. As foresters many of us are inclined to say, "Give us our forests free of rights and encumbrances and we will cover vast acres with magnificent timber of untold value to future generations. What happens? The villager having destroyed his own forests covets the Government reserves. He resents restrictions and the sentences imposed by the Courts and takes his revenge on what he considers to be an unsympathetic government by burning the forests over whose formation and tending generations of foresters have given of their best.

Frequently the demarcated forests are in excellent order and of them we are proud. But what of the rest? Outside the boundaries where there is no control the trees have been felled long ago; flocks and herds have destroyed all young seedlings and erosion is rampant. As the forest disappears the rainwater—and it *can* rain in the Himalayas—pours over the bare surface of the ground no longer impeded by the natural mat of vegetation which is found in the forest, cuts channels in the bare earth, washes away the fertile surface soil of the fields, gathers volume and force and brings destruction in its train. Let us look at photograhps taken outside the forest reserves. Plate 53, Fig. (1), shows goats, the arch-enemies of the forester, browsing; not content with feeding from ground level, they have actually climbed trees.

Plate 53, Fig. (2), shows the remains of a bridge washed away some long time ago, probably when the forests first disappeared from the hills.

A

Plate 54, Fig. (1), shows the damage done to sloping fields sown with maize by one storm last May.

Plate 54, Fig. (2), shows the result of continued overgrazing and neglect. Ravines have cut back into cultivated fields and the damage done is well-nigh complete.

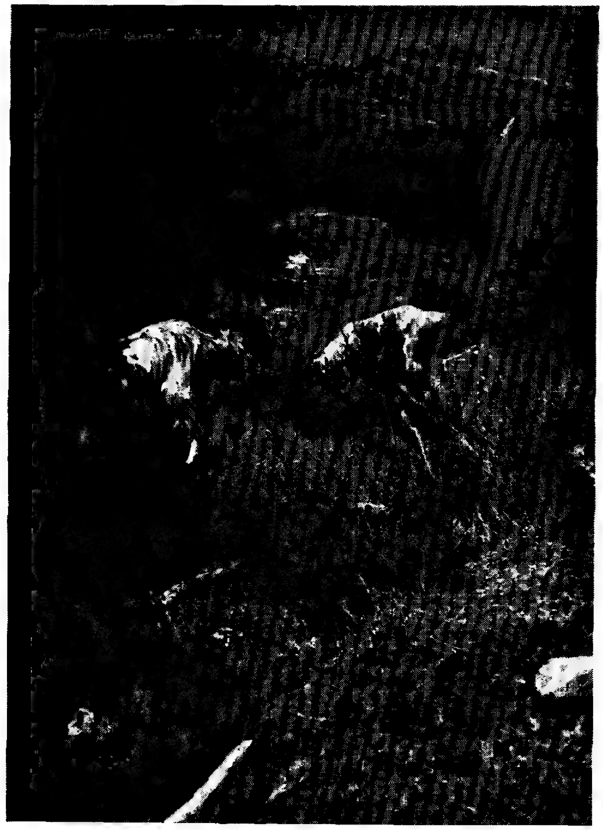
The prevention of erosion and the reclamation of land in the eroded foothills are the tasks which face the newly formed Anti-Erosion Circle of the Punjab Forest Department. The population both of men and animals is excessive and both are living in poverty and rarely get enough to eat. The children of the poorer classes are half-starved and are subject to deficiency diseases and the cows are unthrifty and produce hardly any milk.

Something is wrong with the relationship of the villager to his surroundings. The present regime is wrong as this has resulted in the destruction of the capital resources of the countryside as represented by its fields, pastures and forests. It is essential for us to find out what is wrong and to show the villager how things can be set right. Land planning, regional planning, or whatever the fashionable term may be, is required. Cultivation must be permanent and, to be permanent, fields must be terraced: the rain which falls must, if excessive, be constrained to flow away without damaging the land: if the locality is dry, then all rain which falls must be constrained by means of *wats*, or peripheral ridges, to remain on the fields and to soak into the ground: the pastures must not be grazed promiscuously but must be closed to grazing and browsing wherever erosion is feared in order to produce hay and cut fodder; the forests of the catchment areas of the streams must be strictly preserved and finally Goverment, as the authority ultimately responsible for the wellbeing of the people, must see that wise rules are framed and that regulations are observed. This brings me to the title of this article,

"TRUE SYMBIOSIS IN THE HILLS"

and by this is meant the permanent association of man and his animals with the countryside. His fields and pastures must be permanent and must afford food and fodder sufficient to support him and his beasts and his descendants. His forests must afford protection to his lands, fuel and timber for his own use and a surplus for export in order to bring him a cash return for his labour.

Fig. (1)



Goats browsing.

Fig. (2)

Remains of a bridge.

Fig. (1)

Erosion in a steeply sloping field.

Fig. (2)

The last stage of erosion

Government is vitally interested in the proper management of the land as a whole and, by means of the Co-operative Department, in forming village forest societies whose activities are not confined solely to the forest but embrace the proper management of field, forest, and pasture in one composite whole. Better seed, better farming, better forestry, fewer but better cattle and a higher standard of living are needed if the land is to be saved from ruin.

True Symbiosis. It is an ideal which is by no means unattainable.

PRUNING IN PLANTATIONS

Paper Read at the Fifth Silvicultural Conference, 1939, Item 25

BY M. V. LAURIE, I.F.S., *Silviculturist, F.R.I.*

Summary.—Pruning in India has received little attention so far. Investigations are required to determine what species in India require pruning or would benefit by it. Preliminary indications are obtainable from a study of the knottiness of timber in the depots and from merchants, and from observations of forking and branchiness in plantations. Research is then required into the rate of natural cleaning, with comparative investigations of pruning versus natural cleanings, involving a study of the rate of healing of wounds, susceptibility to damage by fungi, tendency to form epicormic shoots after pruning, etc. The economic height to which to prune, desirability of pruning forks, best age to start pruning, best season for pruning, selection of trees for pruning, etc., have to be investigated and determinations of the cost of the operations with an assessment of the resultant increase of value in the timber are necessary to know whether it is worthwhile. The possible advantages of using wider initial espacements and heavier thinnings, timber cleanness being maintained by pruning, are worth investigation, and the best types of tools and methods of work require study. Brief notes on the above points from European experience are included, as well as on the effect of pruning on increment and bole form, and on the necessity for keeping proper records of all pruning work.

1. *General.*—Every year some 46,000 acres of plantations of different species are made in India and Burma and a much larger area of young crops are raised by natural regeneration. It is our constant endeavour to render these crops as paying as possible. As time goes on the demand for a standardised product, whose properties are as constant as it is possible to make them, will increase and any product whose properties are very variable is likely to be replaced by some artificial substitute. If wood is to maintain its place

in competition with other materials such as steel and concrete, it is essential that the quality of the timber as it is put on the market be as high and as uniform as it is possible to make it.

2. *Degrade in Timber from Knots.*—Among other qualities affecting the grading of timber, that of knottiness is important. Species vary very considerably in this respect, some, especially conifers, being very knotty and others producing timber that is relatively free from knots. Wherever knottiness causes serious reduction in the grade and price of timber, the question of the advisability of pruning is worth investigation. Timber that is grown for special purposes such as veneering and turnery may have to be absolutely free from knots.

3. *Pruning in India.*—Hitherto in India comparatively little attention has been given to pruning. Apart from a few sporadic efforts by keen individuals there has been no regular pruning practice, and but little organised research to determine how far pruning is or is not advisable in certain species. It is our purpose at this conference to discuss the subject and to decide as far as possible what investigations are required and how they should be conducted.

4. *European Experience.*—Pruning in Europe has many lessons to teach us. There have been three distinct waves of enthusiasm for pruning separated by long periods in which pruning fell into discredit and was scarcely carried out at all. Such alternating phases are symptomatic of lack of fundamental knowledge regarding the utility of pruning and the best ways of doing it. In India we do not want to start a pruning craze only for it to fade away after a period of years. We wish to set out systematically to investigate the potentialities of pruning for improving the final product at an economic cost before introducing it on a large scale.

The main reasons for the reaction against pruning in Europe after periods of enthusiasm for it were:

(*i*) Failure to realise the necessity for clean pruning, much of the early work being badly done, leaving snags that later formed unsound knots and even started rot in the stems.

(*ii*) Pruning done too late, either when branches were too big to heal over quickly and escape infection, or when the tree was so big that the benefit of the pruning was confined to a comparatively shallow layer of sapwood. This deceived timber merchants who, on buying clean timber on its external appearances, found a large proportion of the stem full of knots, and pruning was accordingly discredited. If the value of pruning is to be appreciated by the purchaser of timber, it is essential that the size of the trees when pruned should be put on record so that he can judge the proportion of clean timber in the tree. Permanent records of all pruning operations are, therefore, important.

(*iii*) A third and probably the most important reason why enthusiasm for pruning waned was that interest was diverted to questions of crop increment and thinnings for maximum production. Quantity irrespective of quality was at that time the main object. In recent years, however, the tendency to branchiness and poor form in the crops that were heavily opened up has reawakened interest in pruning, and Europe is now well started in its third wave of pruning. As Mayer Wegelin* quotes, "It is . . . the third wave that reaches the farthest up the beach."

5. *Heavy Thinning and Pruning.*—In India at present there is something resembling a mild craze for heavy thinning in almost all crops, heavier at any rate than has been the custom in the past. Few will doubt that formerly many of our crops have been thinned too lightly, but the effect of heavy thinning on timber quality and bole form must not be lost sight of. In all the very heavy types of thinning in Europe (*e.g.*, "Free Thinnings," "Schnellwuchsbetrieb," etc.), pruning is regarded as essential, and this may very well also be the case with the heavy thinnings that are so popular in India nowadays. Pruning is often regarded as costly and uneconomic, and if done on unsuitable species or under unsuitable conditions, this may well be

* *Ästung* (Pruning), by Mayer-Wegelin (1936).

so. In the case of heavy thinnings, especially where material removed is unsaleable, it may be cheaper to thin heavily at longer intervals *and* to prune than to do more frequent lighter less remunerative thinnings. Where, however, thinnings are saleable at a profit the question becomes more doubtful, and is to a great extent depedent upon the increase in price per cubic foot that is obtained for larger sizes. Where the price increment is large it may pay better to thin heavily and prune, while where the price increment is small it may be more economic to thin lightly so as to obtain clean timber without pruning. It is so much a question of the capacity of the individual species for natural cleaning, and of the market conditions that it is impossible to generalise. Jacobs* points out in his Australian researches on pruning *Pinus radiata* (which incidentally, are an excellent example of the way in which pruning investigations should be conducted), that the benefits of the pruning are to a great extent nullified by the heavy thinning, which causes heavier branching and worse form in the unpruned part of the stem, and generally prunings carried above 18 to 24 feet are not practicable. Thus every individual case must be considered separately on its own merits, and the advantages of rapid increment, clear partial bole through pruning and, possibly, reduced costs of initial establishment at a wider espacement, with the associated disadvantages of the cost of pruning and heavier branching on the greater part of the stem and reduced intermediate yields have to be balanced against the advantages in the lighter thinned crop of saving the cost of pruning and better returns from intermediate yields, with its associated disadvantages of more frequent thinnings and possibly higher establishment costs, slower individual tree increment (though probably slightly higher total crop increment per acre), and the all-important question of success or failure in obtaining clean timber by growing the crop at the closer espacement.

6. *Effect of Pruning on Forms.*—Jacobs* incidentally points to the more tapering form in heavily thinned plantations as a further disadvantage. Actually if green pruning is done, the form is improved since the rings in the unpruned portion are wider than in

* Notes on Pruning *Pinus radiata*, Pt. I, by M. R. Jacobs, Commonwealth For. Bureau Bull. No. 28 (1938).

the pruned portion of the stem, and the form factor is increased. It is well known that the form factor of a tree (as was shown by Tor Jonson) is an inverse function of the length of the green crown, and if by green pruning we reduce the length of the crown, the form is improved by a drop in the increment of the lower part of the stem. Dry pruning of dead branches does not, however, affect form appreciably.

7. *What Species should or should not be pruned.*—The question of what to prune and what not to prune is of the first importance. In Europe, for instance, species like spruce or Douglas fir which may retain their dead side branches for seventy years or more, pruning is essential for the production of clean lumber. Larch, silver fir and Scots pine,* in increasing order of rapidity of natural pruning, are also considered to be worth pruning, though under some conditions pine may be left unpruned. Broad-leaved trees generally clean themselves more readily than conifers, oak being slower than beech. In some cases oak is considered to be worth pruning but beech never.

In India our first task is to determine what species are likely to be worth pruning. The best sources of preliminary information are the timber depot and the timber merchant. Wherever degrade due to knottiness, or bad form due to forking are found, the advisability of pruning is worth considering. Various opinions have been expressed from time to time. In Bengal, low forking species such as *Cedrela toona, Terminalia myriocarpa, Chickrassia tabularis,* etc., have been suggested as suitable subjects for pruning, and it was also suggested for sal, but later experiments showed that sal should not be pruned. *Blanford* recommends pruning in teak plantations, with particular reference to low forks, and *Robinson* for teak in Godavari in Madras. Mulberry has to be pruned (Chhanga Manga, Punjab) in order to get the clean stems necessary for the sports goods trade, side branches being removed when as small as possible, and not allowed to exceed thumb thickness. No opinions are on record regarding pruning of conifers in the Punjab or N.W.F.P., though they must have

* Romell found that the time for complete occlusion in naturally pruned Scots pine varied from 25 to 100 years, averaging about 65 years for Sweden.

been expressed from time to time. As in Europe, spruce and silver fir would almost certainly benefit from pruning if timber is required for constructional purposes, and the dreadfully knotty timber of chir pine that is everywhere seen on the market would be greatly improved in value by early pruning. As an extreme example of persistent branchiness in which pruning would be essential in order to get clean timber, *Tsuga brunoniana* in Bengal may be quoted. The benefits of pruning *Dalbergia sissoo* which is now grown at wide spacements and thinned heavily are worth investigating, but care to avoid fungal infection is necessary. Numerous other trees with naturally branching habits (e.g. *Melia azedarach* and *Albizzia, Dalbergia latifolia, Pterocarpus dalbergioides, Swietenia macrophylla,* etc. etc.), suggest themselves.

8. *Side Branches and Forks.*—Pruning may be of two somewhat different kinds. There is the pruning of side-branches for the reduction of knots such as is typically done in coniferous crops, but also in some broad-leaved crops, and there is the pruning of forked leaders so as to increase the length of single bole. The latter operation is more typical of broad-leaved species. It may, for instance, happen that a tree cleans itself sufficiently readily to make the pruning of side branches unnecessary, but at the same time it may have a tendency towards the production of many leaders. Such examples that come to mind are multiple forks in young sandalwood plantations, and in *Cedrela toona* and *Pterocarpus dalbergioides,* which would benefit, if pruned sufficiently early, such pruning of forks should probably not be attempted, however, except at a very early stage, as the danger of rot or other defects from pruning large forks is considerable.

9. *Pruning Experiments.*—Having determined, from observations of the general knottiness of timber in the sales depôts and by observations of tendency to fork or to retain side branches in plantations, whether a species is likely to be worth pruning, it is necessary to carry out further investigations to substantiate this. When it is remembered that in Europe doubts have from time to time arisen about the advisability of pruning even spruce (doubts which were generally due to incorrect pruning technique), it will be realised how necessary it is to substantiate by experiments the desirability or otherwise of pruning crops of likely species before launching out on

large pruning schemes. Points that have to be investigated are:

(1) The rate of natural cleaning of side branches and the probable diameter of the natural knotty core.

(2) The results of pruning as compared with natural cleaning in respect of:

(*i*) Size of knotty core.

(*ii*) Rate of healing of wounds.

(*iii*) Damage by fungi.

(*iv*) Tendency for the formation of epicormic shoots ("water-sprouts") from pruning wounds.

(3) The height to which to prune, and whether this should be done in one, two or more operations.

(4) Whether green pruning should be done and, if so, how much of the crown should be removed. Results would be judged by:

(*i*) Effect on increment, and time taken for reduced rate of increment to return to normality.

(*ii*) Damage by fungus attack and hence desirability of either "stub-pruning" in two stages or of using a protective coating.

(5) Whether pruning of forks is desirable and, if so, at what size?

(6) Best age or ages at which to prune.

(7) Best season of the year for pruning.

(8) The number of stems per acre that should be pruned and how far costs can be reduced by selecting a limited number of stems and pruning them only.

(9) The cost of pruning and an evaluation of the benefits from pruning. This has to be worked out for the different methods of pruning that appear most suitable as found from the above experiments.

(10) The possibility of using wider initial espacements (to reduce plantation costs) and to thin more heavily and less frequently (to reduce thinning costs and to get more rapid individual tree increment), in pruned crops.

Certain general questions may also have to be investigated such as the best types of tools for pruning, and whether ladders and hand-

saws are preferable to pole saws worked from the ground, etc. Small details of technique may have a very marked effect on pruning costs and it is most important that the most efficient methods be determined.

10. *Experimental Technique.*—As far as the more qualitative experiments are concerned, e.g., the qualitative aspects of items 1 to 7 above, the technique is fairly simple. Comparable pairs or sets of individual stems can be selected for differential treatment and the results analysed in the usual way. Some 80 to 100 comparable sets of stems per treatment are likely to be required to get reliable results. When, however, it is a question of determining costs and economic results, it is usually necessary to work in replicated and randomised plots of a size sufficient to give a reliable measure of the factors under investigation, and the experiments are liable to become unwieldly. Good examples of the experimental technique for pruning experiments are given by Jacobs* in his Australian work on *Pinus radiata.*

11. *Some Notes from European Experience—Natural Pruning and Healing.*—In the course of natural pruning the branch dies slowly, during which period a protective layer is usually laid down at the base of the branch. This may consist of thickened cell walls, or cells blocked by tyloses or, in conifers, deposits of resin, and constitutes a barrier against fungal infection. Hence wounds from branches that fall off in the course of natural pruning are generally less liable to fungal attack than artificial pruning wounds. In some cases, however, this danger is counteracted by the more rapid occlusion of green pruning wounds as compared with natural pruning.

12. *Clean Pruning* is of the first importance. A stump of only quarter to half an inch may make very many years' difference in the time taken to heal over. The swelling at the base of the branch should always be cut through. Callus development is most rapid from the sides of a wound, less rapid at the top, and very slow (frequently negligible) at the bottom. In cutting a branch sloping up at an angle from the main trunk, the wound heals much more rapidly if the cut is parallel to the main trunk and close up against it than if it is at right angles to the branch, in spite of the fact that wound area may be very much larger.

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* Note on Pruning *Pinus radiata,* Pt. I, by M. R. Jacobs. Commonwealth For. Bureau Bull. No. 28 (1938).

13. *Age or Size to Start Pruning.*—Pruning must be done as early in the life of the tree as possible, as the branches are then small, pruning is cheaper, healing quicker and the diameter of the knotty core will be smaller. The limiting factor is the height of the green crown. If done at a very early age, only a small length of stem can be pruned without seriously encroaching on the green crown and causing serious loss of increment. The larger the trees are when pruning starts, the less improvement in value will be obtained.

14. *Best Season for Pruning.*—General experience indicates that most rapid healing is obtained if pruning is done in the late winter or early spring (February-March in England) shortly *before* active growth commences. Species may, however, vary as regards the best pruning season. Generally pruning should never be done during periods of active growth on account of the likelihood of the bark "slipping" and the cambium separating from the stem at the edges of the wound.

15. *Healing of Green and Dry Pruning Wounds.*—Pruning wounds of green branches heal more rapidly than those of dead branches but are somewhat more liable to fungus attack. Widespread green pruning should not be done until it has been proved safe.

16. *Stub Pruning.*—Where danger of fungus attack is serious, "stub-pruning" may be resorted to, i.e., the branch is first lopped leaving a stub of 18 inches or more with, if possible, a green twig or two to keep it just alive. Left for a number of years, it lays down a protective layer at the base and forms the usual basal swelling. It is later pruned off close, cutting through the basal swelling, when the wound heals comparatively rapidly. This means two prunings and is expensive, and probably rarely practicable in forestry, being more of an arboricultural operation.

17. *Protective Coatings.*—Alternatively, where a species is very susceptible to fungus attack, protective coatings may be applied to the wounds. Many authorities regard this as being too time-consuming and costly to be a practical forestry operation, but in cases where the number of branches pruned is small, as in many broad-leaved trees, it may be worthwhile, and may make pruning possible where it would otherwise be disastrous.

Though Mayer-Wegelin and others state that the application of coal-tar to wounds does not retard healing, this is contrary to general experience and to the results of experiments by fruit growers. It is found that coal-tar, yellow ochre and *Avenarius carbolinium* cause damage to the cambium and retard healing seriously. White lead paint or white zinc paint and asphalt cause less retardation but are expensive. Applications of lanolin noticeably hastened healing as compared with untreated controls, this result being apparently due to prevention of drying of the cambium and young callus. Attempts to stimulate healing by mixing indoleacetic acid with the lanolin were not successful, probably due to the concentration of the phytohormone being too great. Shellac is a harmless dressing but its protective action lasts only for a short time. The discovery of a cheap wound dressing suitable for Indian conditions may be well worthwhile.

18. *Effect of Increment.*—Heavy green pruning reduces increment. Light green pruning, confined to the lowest shaded green branches of the crown, has little effect on increment. Some say* that these branches even extract nourishment from the tree and that a slight increase in increment may result from pruning them. It is usually worthwhile to sacrifice a little increment for the sake of getting a longer clean bole at one operation but heavy removals of the green crown (more than about 25 to 40 per cent. depending upon the age) should not be done. Incidentally most of the work done on the reduction of increment caused by heavy green pruning has overemphasised the fall of increment in the first few years after pruning. When it is considered that, as the crown develops, the rate of increment returns towards normal, the total volume loss per cent. may be very little. The method of presentation of results has tended greatly to exaggerate the loss.

19. *Height of Pruning.*—Cost increases rapidly with height and varies with conditions. Eighteen to 24 feet is generally regarded as the maximum that can economically be attempted in conifer crops in Europe, using pole-saws or ladders. Since the pruning has to be done when the tree is as small as possible, it may take more than one

*e.g., Keinitz, in *Uber der Bedeutung der naturwissenschaftlichen Grundlagen der Durchforstungslehre*. Zeitsch. fur Forst und Jagdwesen, May, 1931.

operation to reach this height. The fewer the number of operations the cheaper the total cost but the larger the knotty core and the thicker the branches pruned.

20. *Formation of Epicormic Shoots.*—The formation of epicormic shoots or "watersprouts" frequently follows pruning, particularly in broad-leaved trees—though larch also behaves in this way. Such epicormic branching may nullify the effect of the pruning, or at any rate so reduce the value of the operation as to make it uneconomic. In pruning experiments with sal in Bengal and also at the F.R.I., for instance, it was found that three or four years after pruning the pruned trees had many more side branches than the unpruned ones which had cleaned themselves naturally. Teak and *Gmelina arborea* are also liable to produce similar shoots from pruning wounds

21. *Selection of Trees for Pruning.*—All the trees in a crop should generally not be pruned as it is uneconomic to prune trees that will not be retained for the final crop or for the last thinning or so. In regular close crops, depending upon species, the number of trees selected for pruning may vary from 100 per acre to about 250 per acre. Pruning should be confined to the "trees of the future," omitting weakly, suppressed and malformed stems, etc., that are likely to be removed in thinnings. Where, owing to natural pruning, it may not be possible to detect later in the rotation which trees have been pruned, the pruned trees should be clearly marked by paint marks or in some permanent manner so that they can be favoured in thinnings. Though externally they may not appear any cleaner than the other trees, they will be more valuable as they will contain a larger amount of clean timber round a smaller knotty core.

22. *Tools for Pruning.*—Saws are now almost universally accepted as the best pruning tool for forest crops, and a number of excellent designs are now on the market. Axes, chisels and bill-hooks may be as good in really skilled hands for easily accessible branches, but generally the saw results in a higher standard of work. For high pruning, where trees can easily be climbed by the branches, pruning is done by climbing to the required height and pruning downwards with the hand-saw. This is known as the "Tarzan method" in America and is superior to ladder pruning in easily

climbable stands, especially for pruning heights above 15 feet. Where climbing is difficult, then either pole-saws or light ladders with a specially designed loop at the top to rest firmly on the trunk may be used. The relative merits of pole-saws or ladders are hotly contested, each having their advocates.

23. *Cost of Pruning.*—In branchy conifer crops, the cost of pruning up to about 18 feet in Europe brought forward to the end of the rotation at 3½ per cent. compound interest works out at about two to three shillings per tree. Labour in India is cheaper but may work less rapidly, and the branchiness of the crops also varies considerably. On the whole, if efficiently trained coolies are employed, pruning should be considerably cheaper in India, and hence more worthwhile.

24. *Pruning Records.*—The maintenance of proper records of all pruning operations is of the first importance. Not only are they likely to be valuable for scientific purposes, particularly for sawmill analyses of stems of known pruning history, for studying the rate of healing, bark inclusions, rot and general effect on timber quality (there is always a dearth of material of known past treatment for such work); these records are also of value when selling the produce, so that the purchaser can know that a certain length of bole and thickness of wood is guaranteed free from knots, and can accordingly bid a higher price for it. Such pruning records should note the age of the crop when pruned, the mean diameter of the trees, the height to which pruning was done and whether all the trees were pruned or only selected dominants and, if the latter whether these have been marked so that they could be retained in thinnings and so that no unpruned trees would appear in the final crop.

A FIRST RECORD OF TOTAL CHANNEL OCCLUSION IN PINUS LONGIFOLIA

By F. C. Ford-Robertson

Abstract.—In two sets of channels for resin tapping in *Pinus longifolia*, one showed 60 per cent. of the channels healed after 40 years and the other set, which healed more rapidly, showed 31 per cent. healing after only 20 years. The earliest complete healing was found only 10 years after tapping. Growth conditions in both cases are definitely above average.

Kumaon, home of the resin industry in this country, has now entered its fifth decade of tapping. It seems strange, therefore, that no one on the spot has so far taken the opportunity offered by uniform regeneration fellings to discover how occlusion of the old resin channels was progressing and so check up on previous conclusions of resin research.* That opportunity, however, has recently come my way.

2. Parts of Kaligadh Compartment 8 of Ranikhet Range in the Commercial Chir Working Circle were finally felled in the 1939-40 cold weather, completing the following history.

Silviculture		*Resin*
1st seeding felling ...	1898-9	1st cycle of tapping—1892 to 1902 with several faces on trees of $4\frac{1}{2}$ feet bhg. and up.
2nd seeding felling ...	1908-9	2nd cycle of tapping—1917—21, with two faces on trees of six feet bhg. and up.
Final fellings begun ...	1939-40	3rd and final cycle of tapping—from 1934 onwards, all standards under heavy tapping, i.e., multiple faces.

The compartment history records few fires and as people from the near-by cantonment have generally kept this portion of the compartment picked clean of leaf-litter (*pirul*), fallen fuel and woody undergrowth, such as have occurred were probably seldom severe. The area is free from grazing but regularly grass-cut. It may be noted that over forty years have elapsed since the first seeding felling and we are still waiting to complete regeneration in this compartment. Silviculturally that is just too bad. But from the standpoint of resin research it represents the greatest good fortune, affording us a miniature museum full of occlusion studies in cross-section, dating from just before the now almost legendary Boer War. To be precise, out of 130 standards involved in the felling,

*See paragraphs 8—24 of Forest Bulletin No. 51. This investigation which was conducted wholly on standing trees, not on tree sections, has remained our sole guide to the rate of occlusion in tapped *P. Longifolia*.

about 50 taped $5\frac{1}{2}$ feet bhg. or more and hence offered promising material for study. Unfortunately even those were not all available. A number of stumps had got charred in the course of slash disposal work; others had splintered badly at felling; and, finally, although numerous cases of total occlusion were discovered, a large percentage of these (30 out of 64) had to be rejected as the channels had been cut through at felling three inches or less from their base or close to the second year lip and would therefore show abnormally rapid healing. In cases of doubt the channel was barked and the base exposed. I was finally reduced to twenty-three clear sections, varying from 5 feet 10 inches to 7 feet 11 inches in girth, as follows:

Basal girth:	5′—6′	6′—7′	7′—8′	*Total*	*Remarks.*
Nos.	2	13	8	23	Twist negligible.

The field form, which is too long to give here in full, included for each section:

(*a*) The year of face for the 1st and 2nd cycles of tapping (all 1898 or 1899 and 1917 or 1918).

(*b*) The number of healed-over, i.e., totally occluded channels, in each cycle.

(*c*) The total number of channels cut in each cycle and for every occluded channel.

(*d*) The number of years that occlusion had been complete.

(*e*) A record of fire damage and of the channel's position relative to slope.

Figure 1 of Plate 55 shows the general appearance of the stumps, this being one of several sections cut and removed for more leisurely, detailed analysis from *gelis* or butt-logs left at site.* The unsystematic and, therefore, wasteful spacing of the channels is a common feature; even the final heavy tapping (as at C) shows a cavalier neglect of spatial possibilities, though this third and final set of

*Only four such *gelis* were left by the contractor out of 35 stumps examined, an interesting commentary on the contention that tapped boles are ruined for timber.

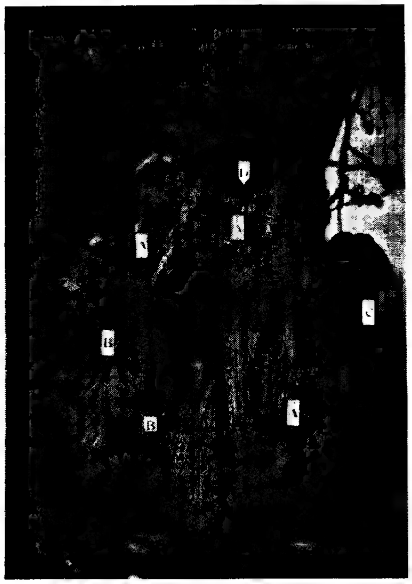


Fig. 1.—Section cut just below breast height, and about mid-face, from a seed-bearer felled in October, 1939, aged 175 years, and showing three sets of channels:
"A" (three)=cut in 1901.
"B" (three, two labelled) cut in 1920.
"C" (five, one labelled) cut in 1936, under heavy tapping.
One "A" channel, at pointer "D," has completely occluded, without any bark inclusion; the other two, which have not, show much fire-damage.

Fig. 2.—Similar section to that in Fig. 1, from a seed-bearer 143 years old, showing three 1901 channels, one channel of 1920 (at 9 o'clock) and five of 1936. Here, too, one "A" channel (at 12 o'clock) has completely occluded, with substantial bark inclusion, while the other two, which have not, have been badly fire-damaged. Note the clear outline of the old channels.

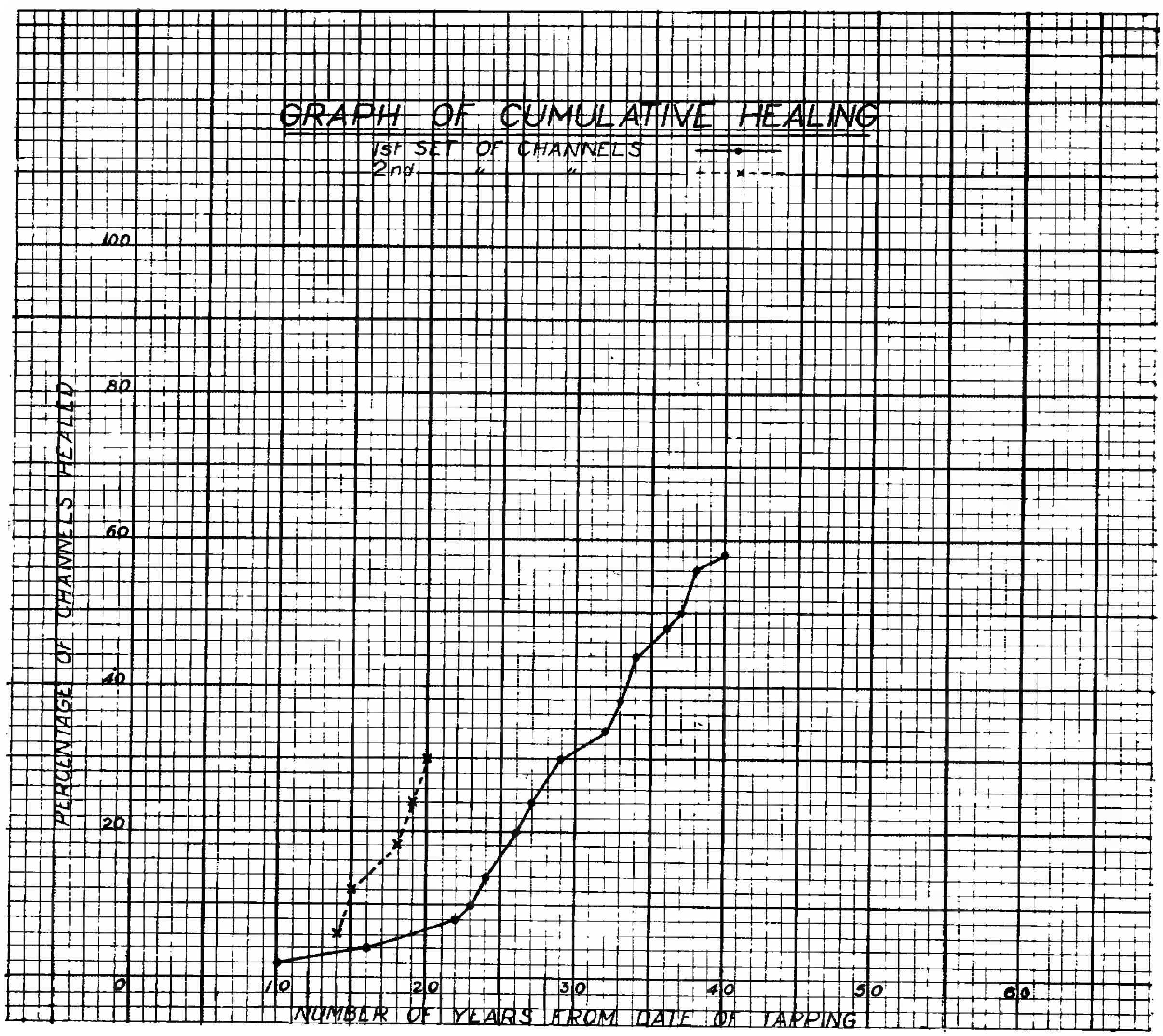
Fig. 3.—Complete occlusion in 31 years: a close-up of the occluded channel shown in Fig. 2.

The occlusion tissue met eight years back, i.e., in 1931-32, but a thin sliver of cortical tissue remained intercalated for four years, the wood elements not fusing completely till 1936. The occlusion runs right through this six-inch stem section but on the other side is only five years complete.

Note: (*a*) The bark inclusion and clear outline of the old 1901 channel from the shoulder of which 39 annual rings can be counted.

(*b*) The phasic rate of occlusion; the first seven and last 15-16 years being very rapid.

Photos by author:


GRAPH OF CUMULATIVE HEALING
1st SET OF CHANNELS
2nd " "
PERCENTAGE OF CHANNELS HEALED
100
80
60
40
20
0
10
20
30
40
50
60
NUMBER OF YEARS FROM DATE OF TAPPING

channels is of no particular interest to the investigation. Figure 2 Plate 55, is a section from a second *geli,* in which the same three sets of channels and the same haphazard siting can readily be distinguished.

3. The main data collected in this way from these 23 stumps can be summarised as follows:

TABLE I

PROPORTION OF CHANNELS TOTALLY HEALED

Number of stumps studied.	*Number of channels found* — Of the 1st tapping cycle, per cent.	*Number of channels found* — Of the 2nd tapping cycle, per cent.	Proportion of these showing fire damage (frequency of damage not computable), per cent.
23	Healed 31=60	Heald 5=31	1st cycle = 32 ; 2nd = 60.
	Not healed 21=40	Not healed 11=69	Both cycles = 100, *i.e.*, no unhealed channel was found undamaged by fire.

TABLE II

TIME TAKEN TO HEAL

Years (growing seasons)	10	14	15	16	18	19	20	22	23	24	26	27	29	32	33	34	36	37	38	40	Total Number healed.
Number of channels of first cycle—(*a*) fire-damaged ..	..	..	..	..	..	..	..	1	..	..	..	3		1	..	2	1	..	1	1	10*
(*b*) Not damaged ..	1	..	..	1	..	..	..	1	1	2	3	..	2	1	2	1	1	1	2	..	19*
Number of channels of 2nd cycle (*a*) and (*b*) above together..	.	1	1	..	1	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	5

*Of 31 healed channels found, the sections of two were too damaged to allow of reliable ring counts.

The above figures are represented in the form of cumulative healing curves in Plate 56.

TABLE III

NUMBER OF CHANNELS HEALED PER TREE (STUMP)

Number of trees (Stumps).	Number of Healed Channels Found			REMARKS.
	Of 1st Cycle.	Of 2nd Cycle.	Total per Stump.	
2	3	..	3	(a) One of these had a solitary 1898 channel which had healed but was rejected because cut through too near the base; the other had none, possibly because below tappable size in 1898 (basal g. 6 feet 8 inches).
1	2	1		
6	2	..	2	
1	1	1		
11	1	..	1	
2(a)	..	1		
23				

Despite the limited material at my disposal, these results—the first, so far as I can discover, on this subject—should be of interest to resin D.F.O.s in India. Twenty years ago, when Champion in his Bulletin No. 51 estimated that our four-inch broad by one-inch deep faces should heal over in anything from 50 to 100 years,* no one, I believe, had ever set eyes on a completely occluded channel; our tapping was then at too early a stage to justify search—if any-one ever bothered about the matter at all. Actually, as Table II indicates, under very favourable conditions complete occlusion can occur within a far shorter period—say 20 to 30 years. The single and exceptional instance of healing in ten years is perhaps worth a fuller note. This particular tree, No. 28 of my field form, girthed 6 feet 6 inches at stump and all three channels cut on it had healed, though at very different rates, as follows:

Serial No.	*Year in which cut*	*Relation of face to slope*	*Number of years taken to heal*	*Healed*
1	1898	170°	10	32
2	1898	120°	34	8
3	1917	30°	20	3

*The average occlusion rate was given as between .04 and .08 inch per annum. These figures, of course, exclude bark.

None of the channels had suffered fire damage and, like the majority of channels observed, they had been cut rather shallow—about $\frac{3}{4}$ inch. Nevertheless, it is a remarkable fact that this tree had succeeded in healing over one channel in the very year that secondary seeding fellings had made it an isolated standard. Among the many trees felled at that time, their occlusion secrets bared at stump, a lynx-eyed officer might well have spotted some more, had the possibility ever crossed his mind. We have waited another thirty years to discover the phenomenon.

Other points that emerge from the tables—though one must not labour such fragmentary data—are:

(1) The channels cut in 1917 and 1918 average a far shorter time to heal over—their close grouping may be noted. This may be attributed partly to the full stimulus of the secondary seeding felling and partly to less intense fires, due to starting control burning from 1921. It is certainly not due to any difference in channel dimensions, if anything, cutting in the second cycle of tapping was rather deeper, while maintaining the same breadth.

(2) Despite the above, a greater proportion of the 1898-99 channels had healed. This, of course, is due essentially to the time factor; provided fire-checks are not too frequent or severe, all channels should eventually heal over.

(3) No relation could be traced between rate of healing and the position of the channel relative to slope;

and, from the field form:

(4) Bark inclusion, as exemplified in Figure 3, was found as follows:

1st cycle (*a*) fire-damaged ... 7 out of 19 or about one-third.
(*b*) Not damaged ... 4 out of 10 or two-fifths.
2nd cycle ... ... No cases;

While thin slivers of intercalated bark occurred in 62 per cent. of the 1st cycle channels and all of the second, separating in one case as many as 14 years of woody occlusion tissue. In no case were *lacunae* found —occlusion, by bark or woody elements, invariably proved 100 per cent. solid.

It must again be emphasised that the trees studied had grown under far more favourable fire conditions than the general run of compartments throughout the division—or, for that matter, Kumaon *chir* forests as a whole. In addition, edaphic factors known to favour rapid occlusion were nearly all operative, viz., optimum elevation (5,800 feet) and aspect (N. and E.), although site quality did not exceed II-III. as well as the following individual tree factors:

(*a*) Selected vigorous trees, free-growing from the outset.

(*b*) Lowest portion of face (mostly basal channels) alone studied; healing is quickest there.

(*c*) Generally shallow channelling, average about $\frac{3}{4}$ inch.

(*d*) Channels spaced well away from each other and tapping only intermittent.

Perhaps without this exceptional combination of favourable factors, in fine, under ordinary divisional conditions, where repeated and rather heavy scorching is probably the worst handicap, complete occlusion will be a rare occurrence and, therefore, of no practical value. In any case, it seems doubtful from the examples I have been able to study whether the Kumaoni tapper could ever be got to channel the healed-over faces, owing to their involuted shape (see Fig. 3, Plate 55 and no one knows, if he were to do so, whether the new channel would give a worthwhile yield. However, the meagre data I have been able to gather do indicate the possibility of faces occluding in a far shorter period than previously expected; so that it should be worthwhile looking out for cases in the course of even casual fellings, as for rights and petty sales, in coupes first tapped at least 20 years ago and not continually subjected to fires. Completed occlusion can never be determined from the outside. If ever we can get adequate control of the management of our *chir* forests—notably as regards fire, grazing and adequate thinnings, this question of channel occlusion may become of real importance to the resin industry.

THE HAUNTED HILL

By E. C. Mobbs

During a recent trek in the Kumaon Himalayas, I was seated in the shade of a pine tree on the grassy top of a steep hill, overlooking an extensive valley, with precipitous sides sparsely covered with pine and oak forest, giving place in the distance to a long line of the Eternal Snows. With me was a companion, whom we will call, for convenience, "Long." He is a mountaineer of great and wide experience and a learned man of scientific outlook. It was while we were seated that he told me that we were on the top of "The Haunted Hill." I could neither see nor sense anything haunted about it, so pressed for further information. The following is the story that he told me. As one of the principal characters, he vouched for its veracity. The combination of strange circumstances, for which he could offer no explanation, made him give the hill its name. I offer you his story without further comment.

Some years ago, Long, with two friends, whom we may call, not ineptly, "Stout" and "Short," left Naini Tal for a shooting trip in the Kumaon Himalayas. One day, having a fairly short journey to perform, they sent their luggage off on coolies and decided to make a detour themselves through the forests. This involved climbing two steep hills. The shikari who accompanied them tried to dissuade them, saying that although they might possibly shoot something on the nearer hill, they certainly would get nothing on the farther hill, as it was owned by a *devta,* or god, who jealously guarded all game living in his domain. This declaration only made the trio keener than ever to try their luck in this place of mystery. Woe to them, they did so!

Accompanied by the shikari and a coolie carrying a small tiffin basket, the party set out light-heartedly for the first climb. A few pheasants were met on the way and two or three were bagged. Soon the slope got steeper and steeper and it was all they could do to clamber up the rocks, Stout in particular finding the going hard.

It is a long slope that has no resting place, however, and eventually the party came upon a small part of the ridge, on the top of an enormous precipice, where they could sit on a level grassy spot

with their legs dangling over the precipice. The three friends took off their topees and placed them on the grass beside them. It was one of those clear winter days, with no wind, a clear deep blue sky and a magnificent view of the snows.

Suddenly, with no warning and without any apparent cause, Short's topee lifted itself from the grass and went rolling down the precipice. While Long and Stout leaned forward to see when and where their friend's topee would land in the valley below, their own topees were also mysteriously displaced and went careering after the first. There was no hope of regaining the topees without hours of labour, retracing their steps down the precipitous slopes, so they decided to abandon their topees and to move on.

They were now approaching the *devta's* hill, when suddenly Stout complained of feeling unwell, and it was only with some difficulty and by dint of encouragement that the other two could get him along at all. After a short rest, however, he soon got over his indisposition and all three were merrily clambering over the rocks again when Long spotted a *ghural* (Himalayan chamois). As soon as they stopped, the shikari announced that he could see a number of *ghural* on the hillside the other side of a nulla or small valley. But he declared it would be hopeless to try to shoot them, as although they were well within range, they were in the *devta's* preserves.

Nothing daunted, all three were soon pointing their rifles at the *ghural*, each picking out a separate animal. They fired simultaneously and two *ghural* were seen to fall and roll down the hillside. Quickly re-loading, they fired another fusilade, and then another and yet another. Let it be said at once that at least two of the three were "marksmen" and were reputed to be able to hit a rupee at a hundred yards. Imagine their disgust, therefore, when they saw the supposed dead *ghural* recovering themselves and running helter-skelter over the hill. The *shikari*, like the bird of ill-omen that he was, kept croaking "I told you so."

By now it was beginning to get dark, and it became clear that a move towards home would have to be made quicky, so after a little refreshment from the lunch basket, they set off in the direction of their home. But at this juncture, Long began to feel dreadfully ill, and Short also complained that he was none too well. They were

still several miles from home and difficult ground remained to be crossed. It was soon evident that they were benighted, with one sick man almost unable to move. On the shikari saying that there was an abandoned sawyers' hut close by, they quickly repaired to that place and decided to stay there for the night. It was a shed some twenty feet long and ten feet wide, giving ample accommodation for the party. The roof was low and the door small, so that one had to enter almost on one's hands and knees.

It was the month of November and the night was cold and frosty, so they were glad when a fire was lighted on the floor in the middle of the hut in the old sawyers' fireplace. With their feet close to the fire, they were all, including the coolie and the shikari, soon sleeping the sleep of exhausted men. The lunch basket was near them, and on the top of it were Long's binoculars and Stout's gold-rimmed spectacles. Ammunition, incidentally, had been placed in the basket.

Suddenly, at about three in the morning, Stout leaped up shouting that the hut was on fire. Sure enough it was and the old wood of which it was made was burning up with fiendish speed. There was an immediate stampede. Short, who was near the door, was out in an instant. Long followed, but more quickly than he had intended, for his bent body was struck by Stout's large head, and he was sent rolling head over heels some distance down the hillside. The ammunition in the basket was popping off merrily, and the fire was spreading along the ground, which was strewn with pine needles.

All set to work with branches, quickly broken from trees and bushes around, to beat out the spreading fire. Fortunately, they succeeded otherwise they would have had a forest fire to answer for. From the ashes of the lunch basket they recovered only the skeleton of Long's binoculars and his toilet mug, which he treasures to this day. Stout's gold-rimmed spectacles had completely vanished! Luckily the guns and rifles had been saved by the shikari pitching them out of the hut. This philosopher had kept his head in a wonderful way and the trio afterwards acknowledged their indebtedness to him in a substantial manner.

At daybreak a very sorry-looking quintette wended their way home from "the haunted hill."

This is not the end of the story, however. Three years later, accompanied by the same shikari, Long went again to "the haunted hill"; climbed up the same steep hillside, reached the top, saw some *ghural,* fired several carefully-sighted shots, but missed every time. He went on a few paces and, at identically the same spot, he got violently ill again. With difficulty did he get away with the shikari's help. After walking five hundred yards or so, he got completely well and marched gaily home.

TIMBER EXPLOITATION IN THE PUNJAB HILLS

By R. S. Chopra

Wood has been the chief structural material of all times. It holds its ground even to-day in spite of timber substitutes in the shape of metals and concrete. The consumption of wood per capita even in the sophisticated west has not fallen, whereas it is steadily on the increase in this country. But there is a deplorable lack of knowledge among the public about this essential basic material. The consumer in the towns does seem to know in a way that forests in the hills form the source of timber supply but beyond this he has little or no idea of the amount of care, thought and labour involved in the production of every piece of timber for his use. Let us, for a moment, get behind the scenes and try to grasp the link between the mighty Himalayas—its giant trees—and our railroads, our door posts and roof joists, our toothpicks and match-sticks, nay every bit of wood required for the small necessities of life.

Building Timbers.—Deodar, Chir, Kail or Andhar (Blue Pine) and *partal* (Spruce and Silver Fir) are the principal trees that furnish building timber to us. They all grow in the Himalayas at different altitudes, more or less in well-defined altitudinal belts except for Kail. The *Chir*-pine is found lowest of all at 3,000 to 6,000 feet elevation, then comes Deodar from 6,000 to 8,500 or 9,000 feet and above them the firs up to an elevation of 12,000 feet or so (see Plate 57, Fig. 1). *Kail* is very companionable, forming an association with Deodar hobnobbing with spruce and regaining an independent existence even after the fir zone. All these trees are long-lived and attain huge dimensions—a height of 120 to 175 feet and a girth of

anything up to 30 feet and over. They cover an area of over 2,000 square miles in the Punjab hills. The extraction of timber from the remote forests in the interior and its delivery in the plains market, hundreds of miles away from the source, form a stupendous task with which the forest officer is confronted.

Regulation of Fellings.—The popular idea of a forester's job is that he goes about in the forest, has a fine time with his gun and occasionally fells trees when his fancy so directs. This is far from true. Continuity of supply and improvement of growing stock are axioms of forestry which form the basis of all scientific management and exploitation. The cuts are so regulated as to ensure a perpetual supply of timber from each working unit to its full capacity. This is paradoxical but, nevertheless, a fact. Broadly speaking, the fellings can be classified under two heads, viz., Regeneration fellings and Intermediate fellings. The former are carried out when the crop attains physical or economic maturity and its replacement is desired, while the latter aims at accelerating the growth and improving the quality of trees before they become mature, by relieving congestion in the crop at intermediate stages. The Himalayan conifers live for centuries but on an average they attain a girth of 8 feet at breast height in about 150 years when they are considered fit for exploitation. Trees of smaller size than this cannot be profitably converted into railway sleepers and large-sized timber in demand for building purposes. On the other hand, the growth considerably slows down after a tree has lived for 150 years and, with the exception of Deodar, rot invariably starts in other species, rendering the timber useless. The Punjab hill forests are, therefore, worked on a 150-year rotation with intermediate fellings on a graded 10 to 15-year cycle. Under regeneration fellings the mature trees are removed by stages spread over a period of 30 years in order to obtain fresh and new regeneration (i.e. new crop) over the area under exploitation. The speed and intensity of fellings are determined by the establishment and progress of the new crop and by the desired rapidity of growth and quality of timber. Selection of trees for felling is not dictated by fancy but by scientific acumen acquired through years of patient study. The entire operation of marking trees for felling is controlled by well thought out working plans sanctioned by the highest scientific authority in the land on forest matters.

Conversion.—The felling of marked trees and conversion into marketable sizes is the next operation. It is a specialist's job and is carried out by trained labour working under the supervision of trained staff. Felling of these giant trees is by no means an easy task. The art lies in felling the trees in such a manner that least damage is done to the standing crop as well as to the trees themselves during the fall. With this end in view, proper cutting methods have been devised for directing the fall of a tree in the desired direction, though uphill felling is the rule. Big trees are further controlled by means of wire ropes to direct the fall. Branches of trees are lopped when necessary to prevent damage to the surrounding crop. This is done by climbing up the trees and takes a plucky man to do it. Felling work is frequently done in the winter months when snow is on the ground to act as a cushion for the falling tree and prevent it from breaking up. Thus the forest staff and labour have to be up and doing and to rough the cold weather in the forest when the timber consumer thinks of fortifying himself against catching a cold.

After felling come logging and marking off logs for sawing. The operation resembles the cutter's job in tailoring. The person responsible for it is supplied with a list of sizes to be cut for each species in the order of importance in which they are in demand in the market, and he has to exercise his skill in portioning every tree so as to obtain the maximum quantity of sizes that are best sellers, to reduce the wastage to the minimum and to localise defects, e.g., rot, twists, shakes, etc., in as few pieces as possible where these cannot be avoided. When this is done, the logs are ready for sawing. The hill sawyers of Kulu, Seraj and Mandi State have specialised in this work and are engaged on it throughout the Western Himalayas. These hardy hillman live in the forest through rain and storm in temporary sheds roofed with tree bark and refuse chips and carry out sawing from tree to tree. The difficulties encountered in tackling huge logs and establishing saw pits on steep slopes would be better left undescribed. They are far too nerve-racking. The sawyers are by no means left alone in the forest to do as they please. Their work is constantly supervised by the forest staff who guide them at every step and see to proper sawing. Each scantling is measured and passed before payment.

Transport.—Under the present state of development of communications in the inner hills the only economic way to get timber down to the plains is by floating it in the rivers. On completion of sawing, carriage of timber from the hill slopes to the river or floatable streams in the side valleys forms the forester's main concern. Aerial gravity ropeways are commonly used in the Punjab Hills for the purpose, but man-handling plays by no means an insignificant part. The ropeway spans are installed only at a central place in the forest, and timber from all over the area under exploitation is carried to the ropeway loading stations on the back of coolies. The ropeway machine consists of a set of three stationary suspension or track ropes fixed three feet apart and an endless control rope moving on two grooved wheels. The control rope is placed vertically under the central track rope and six feet below it. The load of timber is suspended at the top station from carriers moving on the fixed track ropes and is attached to the control rope by means of a Y coupling. At the same time a spare set of empty carriers is tied to the control rope at the bottom terminal. The load on release moves down with the pull of gravity and empty carriers for the next load come up. Thus the system works automatically without engine power. This simple mechanical device makes it possible to bring down timber quickly and cheaply. But for this the consumer shall have to pay appreciably more for his timber requirements owing to increased cost on extraction.

Where the ropeways deliver timber on the bank of a side stream, we are next faced with the problem of khud-floating to get the timber down to the river. Pieces have to be floated individually in wet slides or "telescopic chutes"—a slow and irksome task. It is not, however, plain sailing even when the timber has reached the river. Roughly 250 miles of river floating is involved before the timber reaches the sale depots in the plains. The operation has to be well timed to save the timber from being swept away in floods. Besides the rivers have a turbulent course in their upper reaches in the hills. Obstructions and cataracts are not infrequent and the timber has to be steered clear of them. After launching, regular labour gangs under the supervision of trained staff accompany the timber *ghall,* keeping the river free of jams and "sweeping" it from

the tail end of the *ghall* to leave no piece behind. *Tarus* and *drei-men* (skin-men) relaunch timber marooned in midstream. The forester heaves a sigh of relief when his timber *ghall* reaches the spot where the river debouches into the plains. At this point a boom is set up across the river to catch individual scantlings which, after collection, are tied into rafts or *tallas* for the onward journey to the sale depots, where the timber is sorted out and graded for auction to the public. (See Plate 57, Fig. 2.)

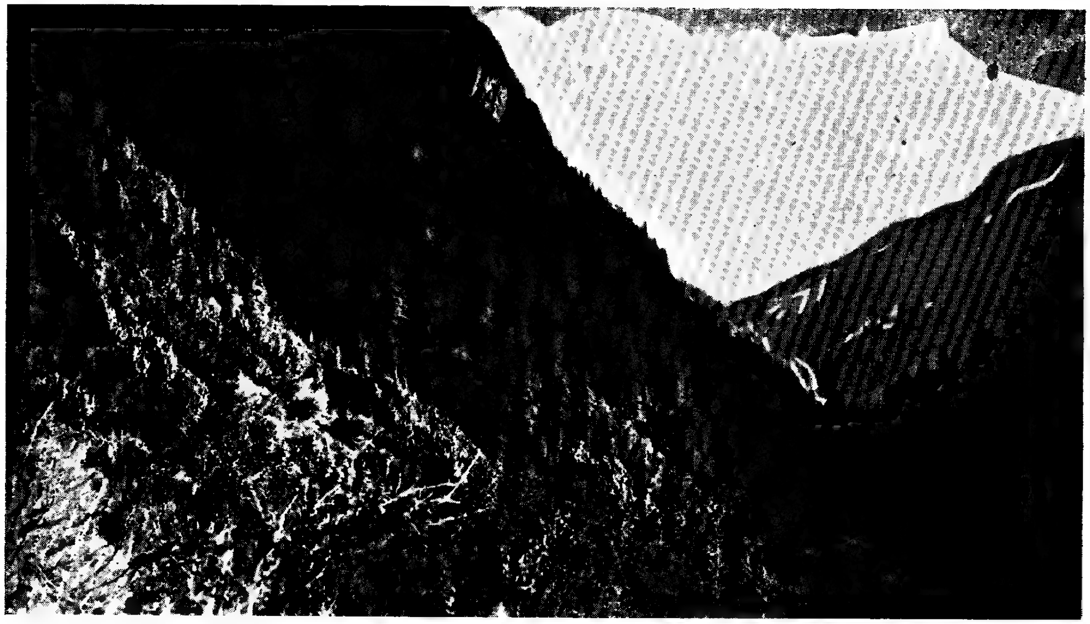
Such is the chequered history of timber exploitation in the hills, not to mention the labour organisation, arrangements for food go-downs, the complicated system of timber accounts and numerous other technical details of management. Yet it all appears so simple to the man in the town who, with money jingling in his pocket, can readily purchase timber from any sale depot, little knowing how the forester has to toil to minister to his requirements, and with what pains the forester protects, conserves and carefully nurtures this rich heritage of nature—the country's forests—for his benefit as well as for the benefit of his children and their children's children.

THE NATIONAL WEALTH OF THE FOREST

By M. Hakimuddin

Its Utility to Man.—Nature first covered the surface of earth with either water or vegetation. Man from the start began utilizing the vegetation in one form or the other to his advantage. In fact he lived entirely on the products of the forest to begin with. He covered himself with leaves, grass, feathers and skins of animals which he killed for food. He lived largely on roots, berries and fruits of Nature's vegetation. As his needs grew and he became more and more wise, he built huts of wood and grass, tamed animals and maintained livestock which he grazed in Nature's forests. With the increase of population and progress of civilization, man cleared the forests, harnessed the animals, constructed ploughs, tilled the land, raised field crops, utilized fibres and timber, built carts, boats, houses, bridges, railways, mills and various other industries which are partially or wholly, directly or indirectly connected with

Fig. (1)



Fir forest at the head of Parbati Valley, Kulu.

Fig. (2)

Rafts anchored at destination.

the forest and its various products. Scientists, through their researches and recorded observations, have proved that a country should have at least 20 per cent. of its area covered with vegetation uniformly distributed, while the United Provinces has only about 7 per cent. of its land under forest. From time immemorial India has been an agricultural country, and agriculture mainly depends on rainfall, fertility of the soil and livestock, while these *three factors*, in their turn, depend on the existence and maintenance of the forests.

Its Utility to a Country.—(*i*) TEMPERATURE.—The presence of forests has a moderating influence on the extremes of temperatures of the neighbouring localities. This has been proved beyond doubt by recording temperatures inside and outside the forest areas. Every traveller has also the same practical experience that it is always cooler during the day under the shade of trees than in the open and, *vice versa*, it is warmer during night under the shade of trees than it is in the open. Large forest areas have, therefore, a moderating influence over a wide belt of the country all round the forests.

(*ii*) RAINFALL.—Similarly, it has also been proved by recording rain-guage results both inside and outside the forest areas that the rainfall is heavier on the forest-covered land than it is on those which have less vegetation or are devoid of forests. For example, in all the submontane and *tarai* tracts from Dehra Dun to Gorakhpur, the rainfall is between 50—80 inches annually, while it gradually decreases with the decrease of vegetation as one goes towards the south and west.

(*iii*) EROSION AND FLOODS.—Observations all over the world have shown that hills as well as plains, which are covered with forest growth and vegetation are, less liable to erosion, landslips and floods than those which are deprived by man of their natural cover of vegetation. In an area thickly covered by forests, a good deal of the rainwater is absorbed in the soft forest soil through the roots of the vegetation and keeps feeding the springs, rivulets and rivers in the following seasons after the rains and, in the plains, keeps the water-level at a reasonable depth in the wells. On the contrary, on barren hills and plains with little or no vegetation, the rainwater

finds no obstruction, rushes down the slopes, causing landslips, washing away the surface soil, carrying large quantities of sand-producing, destructive floods and depositing silt and sand on the fertile plains below, to the misery of its population. What a pity to behold the innocent population suffering from the misdeeds of their brothers somewhere else and wrongly alluding to their trouble as a "calamity," "bad luck" or the "Wrath of God Almighty."

Public Opinion.—It is the general idea of the public and even of some educated and responsible persons that the forests serve no useful purpose, that they are nobody's property, that everybody should have freedom to cut, lop, burn, graze, clear land, cultivate and destroy the forests unrestricted as their forefathers had done before. They look upon the forest staff as a set of undesirable intruders who do nothing useful but enjoy camp life at government expense, shoot and some of the lucky ones even have free joy-rides on elephants. Those whe are used to enjoy pucka roads, safe bridges and comfortable drives on rails, motors, lorries or at least on tongas, surely little know they what in reality forest tours are and what hardships forest officers in general have to face. When duty demands, they have to run to extinguish forest fires in burning sun, very often in places without roads or paths or to protect a falling building, a road or a bridge in danger of erosion in out-of-the-way places during the rains, when rivers and even small *nalas* are in flood and the elephant is the only means of transport. The plantation works, which are on the increase, are mainly done during the rains. Their success and adequate return of the large investments of public money wholly depend on the timely supervision of the sowing, planting and tending during the rains which again is not at all possible in the majority of cases without an elephant. Checking of the estimates on the spot for the annual repairs of the roads, buildings and bridges, early after the rains is very essential both for economy and efficiency and also for setting up early communication for the start of forest works. This again is not possible without the help of an elephant when forest roads and bridges are in bad repair. Even if it looks like a paradise to some picnic lovers as a pleasant change when they are out for a few days from the monotony of their busy town life, I wonder how many of those who think that way would really enjoy

a long, continuous, lonely exile for about 30 of the best years of their lives in the wilderness, far, far away from those dear and near, deprived of all social life and its amenities, timely medical aid, sacrifice of their children's proper bringing up and education, with malarial fever, enlargement of the spleen, gout and dysentery, etc., as associates, which no picnic, however heavenly, can compensate. Thus the average life of the forest staff including their officers is not as enviable as it appears to some picnic lovers. I am sure the keenest of them will soon find themselves fed up many times more than they are with their luxurious town lives if they have to earn their living in this imaginary "paradise." It is not all, for the forest staff have to toil and sweat unperceived and very often without encouragement or reward. They have to perform many functions. They are trained engineers, surveyors, planters, business and estate managers and lawyers. They design and build their own wells, buildings and bridges, align and construct roads, canals and tramways and maintain them; survey and prepare maps and demarcate boundaries; raise plantations and exploit the mature crop as interest, leaving the capital; manage the forest estate and forest villages; settle disputes and decide forest cases according to their own Forest Act and Code. Thus an average forest officer has from four to six hours office work and about the same amount of outdoor work to finish almost daily to earn his bread. As to how they serve the public is left to those who care to see both the dark and bright sides of the picture impartially.

The Economic Aspect of the Forest National Wealth.—It will be better to deal with the statistics of one district in detail, that in which I am serving, and then to apply its conclusions to other districts of this province which have government-managed forests called "The Reserved Forests."

The forests in this district of Garhwal lie mostly in the hills between elevations of roughly 1,000 and 12,000 feet above sea-level. They comprise three forest divisions, namely, Garhwal, Lansdowne and Kalagarh, containing an area of about 1,100 square miles. Their total average gross revenue is about seven lakhs, average expenditure about $3\frac{3}{4}$ lakhs and the surplus is thus about $3\frac{1}{4}$ lakhs of rupees annually.

(I) DIRECT BENEFIT.—Rs. $3\frac{3}{4}$ lakhs at an average are spent annually on the maintenance of staff, buildings, roads and bridges within the forest area, for the management and the export of forest produce, fire conservancy, boundary lines, plantations and works of improvement for the wellbeing of the forest growth. More than 75 per cent. of this $3\frac{3}{4}$ lakhs is spent on local labour and the lower staff belonging mainly to the Garhwal District, while hardly 25 per cent. is spent on outside people. The surplus of $3\frac{1}{4}$ lakhs goes to the Central Revenues of the Province which also, in its turn, is spent on the works of public utility such as the maintenance of law and order, hospitals, schools, roads and bridges, etc., wherever the revenues of the district are insufficient to meet the general needs. Thus about rupees seven lakhs annually are spent in one way or the other on the public directly from the revenue of the forests of the Garhwal District alone.

(II) THE INDIRECT BENEFIT.—It is a well-known fact that the forest contractors have to spend three to four times of their contract value on cutting, sawing and export of the forest produce before they bring it to the market. For instance, a forest contract of Rs. 5,000 will easily require Rs. 15,000 to 20,000 to work it up successfully in the plains and hill forests respectively. The basis of the argument is that the Forest Department sells standing trees and bamboos on the site in the forest. The contractors cut and convert these into marketable articles such as scantlings, beams, sleepers and planks, etc., and then export them to the market. This requires three to four times more expenditure than what the contractors pay to the Forest Department as purchase price. To quote the actual figures, the Forest Department gets, at an average, about annas eight per cubic foot as sale price on sal timber, about annas four per cubic foot on other inferior timber and about annas two per score on bamboos, while sal timber sells at an average of Re. 1/4 and other inferior timber at about annas twelve per cubic foot and bamboos at about Re. 1/4 per score. Due to keen competition, the contractor seldom makes more than one anna of profit per cubic foot of timber or per score of bamboos. The difference between the purchase and sale values is spent on cutting, conversion and export. Thus, for a revenue of about seven lakhs, which the Forest Department of Garhwal

District makes, the contractors easily spend three to four times, viz., about 22 to 28 lakhs of rupees annually for cutting, conversion and export on the labour in this district alone. This labour consists of wood and bamboo cutters, sawyers and carters who come mostly from Garhwal, Kumaon and Bijnor Districts. Hundreds of mules, buffaloes, bullocks and camels are brought for the export of timber and bamboos into the hilly localities from this and the neighbouring districts. Nepal labour, called "dotyals," also come for bringing down timber from steep places where the animals mentioned above cannot work. Thousands of these animals and people migrate annually (some with their families) early in the winter and spread throughout the forests, making temporary huts, and thus earn their living for about four to six months. Thus it is amply clear that the reserved forests of Garhwal District alone provide livelihood to several lakhs of people and animals by spending directly and indirectly about 28 to 35 lakhs of rupees annually. Besides this, the villages bordering within about 10 miles of the Reserved Forests have either rights or concessions for grazing of their cattle, building stones, thatching grasses, timbers for the construction of their houses, agricultural implements and fuel mostly free and some on nominal concession rates, as admitted at the time of forest settlement. If the above materials, which are given away free annually, are converted into terms of money, they will also amount to several lakhs.

It may be surprising to note that 1,100 square miles of forest land in a hilly and difficult country but under the management of the Forest Department, yields directly and indirectly over 35 lakhs of rupees annually for the benefit of the surrounding population, while more than four times the above area, lying directly south of Lansdowne and Kalagarh Forest Divisions between the Ganges and Ramganga, in a comparatively much easier country which formerly contained equally good forests, but under private management, hardly yield over four lakhs of cumulative revenue annually instead of about a crore merely because they have been mismanaged. This proves definitely that the proper management of the existing Reserved Forests, which have escaped destruction, will ensure all the benefits which will not only continue but may even increase in the future, whereas Nature's forest wealth is certain to fall off quickly through

mismanagement or overfelling followed by the famine of timber, fuel and other forest material and, finally, a tremendous increase in unemployement and starvation of men and cattle.

There are 14 more reserved forest divisions in the 10 districts of this province having a gross revenue of about 43 lakhs. On the same basis, as already explained above in the case of the Garhwal District, at least three times of the above amount, viz., about 129 lakhs, in addition to the gross revenue, is spent by the contractors annually on felling, conversion and export of the produce on the labour, which means that a large population of labourers of the province owe their very existence to the reserve forest estates in eleven districts besides providing means of trade and industry to a large number of contractors and businessmen and supplying the needs of the population in general.

To enumerate further the advantages of the forests, hundreds of rural villages depend largely for their requirements, thousands of cattle for their grazing and the vast tracts of cultivation for their agricultural implements and water supply on the resources of the reserved forests. If the above material is also converted into terms of money, it will again amount to several lakhs annually.

These are the great direct and indirect economic advantages of a forest to a country and that is why the forests are rightly called "The National Wealth."

Most of the villages, cattle and cultivation would, in course of time, cease to exist if these forests are destroyed at the present rate. History has amply shown in many countries what devastation has overtaken them with the gradual destruction of their natural forest wealth. Although the process is slow but it is certain and the researches made by scientists from the relics found in the ruins of some of those countries show their past grandeur, which vanished gradually with the destruction of their forests and consequent deterioration of the climate, rainfall, fertility of the soil and the other economic resources of the country. It is, therefore, worth remembering that Nature has not covered our mother earth without purpose.

A note of warning should, therefore, be sounded for those who are keen on the destruction of the forest wealth of these provinces

and who are agitatng and even instigating ignorant people to clamour for the enhancement of the existing rights or the extension of the cultivation into the Reserved Forests, more for the sake of their own name and fame as great "reformers" and "bahadurs." They would be rendering real service to the country and to the future generations if they educate the ignorant and help in the preservation of forest, nay even extension of the existing national forest wealth.

Forest Settlement.—There seems to exist great misunderstanding in the public mind about the settlement of the Reserved Forests and the legal position of the rights and concessions of the people in them.

Some sixty or seventy years back, when the British Government settled down and saw the wanton destruction of the natural forest wealth in these provinces, they framed laws for its reservation and the settlement of the rights of the people in it as laid down in Sections 4—20 of the Indian Forest Act, XVI of 1876.

Usually an experienced civilian was appointed as a forest settlement officer in every forest settlement, who proclaimed by local publication, by notices and by the beat of drum in every village and town in the neighbourhood of the forest which was to be reserved, specifying:

(*a*) The boundaries of the proposed forests;

(*b*) Explanation of the consequences which will follow on the reservation of such forests; and

(*c*) Fixing a period of not less than three months from the date of such proclamation and requiring every person claiming a right to present to the forest settlement officer the nature of such right in writing and the compensation claimed in respect thereof.

The forest settlement officer enquired into all the claims duly preferred on the spot by fixing dates and examining witnesses and records and also recorded those rights the existence of which was proved in the course of his enquiry although they were not claimed. Such rights which were proved to have grown up by long and unrestricted usage into prescriptive rights, *i.e.*, *maurusi*, were only admitted and the rest were rejected.

If the forests were able to stand the burden of the admitted rights, without being ruined, they were allowed to continue and their extent was recorded and fixed. But in cases where the rights were too heavy for the safety of the forest itself, they were either compounded, bartered wholly or in part or such heavily burdened forests were not reserved at all and were left entirely for the enjoyment of the villagers.

Any dissatisfied persons were allowed to appeal within three months of the date of the orders passed by the forest settlement officer to the appellate court appointed by the local government, which was usually the court of the commissioner of the civil division concerned, with powers of a high court, whose orders were final, subject only to revision by the local government. The parties concerned were allowed to have their cases represented by lawyers at both the above courts.

Thus it will appear that these government forests have been reserved constitutionally with all the due formalities of law at the time of settlement with reference to the rights of the people, as they existed then and were settled permanently. Hence these rights do not increase or decrease with the increase or decrease of the needs of the villages or towns to which they are attached. Nor can any new rights accrue or be created in a government forest after the reservation under the Indian Forest Act, XVI of 1876.

The usual argument of the interested parties and agitators is that people in those bygone days were not sufficiently wise and educated, but it does not hold good on the same grounds that the staff of the settlement officers in those early days who did the pioneer work was also not sufficiently wise and educated. Thus in reality there should not be any cause for dissatisfaction on the past settlement. Cases of greater magnitude than the forest settlement are decided every day by high courts all over the country, their decisions are taken as final and no revision is sought for after ages.

REPORT OF THE SOIL CONSERVATION AND AFFORESTATION SUB-COMMITTEE OF THE NATIONAL PLANNING COMMITTEE

By K. P. S.

The National Planning Committee, inaugurated under the auspices of the All-India National Congress, is at present engaged on the task of preparing a comprehensive plan for the development of the country. For this purpose it appointed a number of sub-committees to report on the various aspects of the subject.

This note deals, in brief, with the work done by the *Soil Conservation and Afforestation* Sub-committee.

PERSONNEL

The following persons served on this Committee:

Chairman—Professor J. N. Mukherjee, D.SC., F.C.S., F.R.A.S.B., F.N.I.

Secretary—Professor S. P. Agharkar, M.A., PH.D.

Members—Dr. Amarnath Puri, PH.D., D.SC.

Rao Bahadur Dr. D. L. Sahasrabudhe, D.SC., M.Ag., I.A.S. (*Retd.*)

Rao Bahadur V. A. Tamhne, M.AG., M.SC., I.A.S. (*Retd.*)

Dr. S. K. Mitra, D.SC., I.A.S.

Shri A. P. Wattal, I.S.E.

Mr. N. B. Garde, I.S.E.

GOVERNMENT NOMINEES

Mr. S. H. Howard, I.F.S.

Mr. L. R. Sabharwal, I.F.S.

Mr. K. P. Sagreiya, I.F.S.

TERMS OF REFERENCE

At the first meeting of the sub-committee it was decided to extend the scope of the sub-committee so as to deal with *Soil Conservation and Forestry generally, including Afforestation, Grazing and*

Utilization, under the following sub-heads:

(*a*) Protection against erosion, floods and other detrimental factors affecting the soil;

(*b*) Treating it with manure and fertilisers;

(*c*) Providing drainage and other facilities needed to guard against water-logging, weeds, etc.;

(*d*) Planting of new forests in areas denuded of forests;

(*e*) Care of existing forests and silviculture;

(*f*) Development of forest produce;

(*g*) Establishing or developing industries founded upon forest produce;

(*h*) Provision of transport facilities needed to develop forests;

(*i*) Reclamation of land;

and all other pertinent questions connected with silviculture and industries founded on forest produce.

QUESTIONNAIRE

To elicit information, the sub-committee issued a questionnaire to various departments and individuals in the country. This questionnaire was extremely comprehensive and covered the terms of reference under the following heads:

A.—General.

B.—Soil Erosion and Reclamation.

C.—Conservation of Soil Moisture and Regulation of Water Supply.

D.—Soil Fertility and Crop Production.

E.—Forests.

F.—Forest Produce.

G.—Transport.

H.—Fires.

REPORT AND RESOLUTIONS

On the basis of replies received and information collected by individual members, a comprehensive report was prepared and submitted to the National Planning Committee for consideration.

The National Planning Committee discussed the report at its session held in June last, accepted the report and passed the following resolutions on it:

1. Soils and forests constitute a national heritage. On their successful conservation depend the present and the future of the nation. The state must, therefore, step in and accept responsibility for their conservation.

2. The problems of conservation of soils and forests must be treated as a whole. For this purpose, the system of land utilisation as it obtains at present requires the closest investigation. A land utilisation survey should be conducted by a body of experts and land utilisation maps prepared on the basis of the information gathered. The position should be reviewed every ten years with a view to watching and regulating where necessary the trend of changes in land utilisation.

3. Official statistics show that out of about 827 million acres of the land area, 173 million acres are "cultivable waste, other than fallow," 61 millions "current fallow" and 183 millions "not available for cultivation. One of the most important of the problems which should be tackled by the surveys proposed above and the Land Development Board (mentioned below) is to determine:

   (a) The area actually available for utilisation, under the head "cultivable waste other than fallow" and "current fallow;"

   (b) The conditions under which it could be utilised; and

   (c) The causes why so large a proportion is classified as "cultivable waste, other than fallow."

4. The information regarding land utilisation, for example, that given in "The Agricultural Statistics of India," though useful for some purposes, is not of much help for planning. The collection of necessary and adequate statistical data should, therefore, be the first item in the programme of Soil Conservation.

5. For the purposes of co-ordination and working out of programmes of conservation, a statutory organisation, to be called "The Land Development Board," should be established at the centre and in the provinces and states. The provincial and state organisations should look after the local aspects and the organisation at the centre should take up matters of interest to more than one province. This will serve the purpose of co-ordinating all efforts for conservation of soils and forests and enable the problems to be visualised and grappled as a whole.

6. The Central Land Development Board should deal with:

(*a*) Soil Conservation including soil surveys, soil maps, soil fertility and land reclamation;

(*b*) Anti-erosion measures;

(*c*) Afforestation, reafforestation and improvement of existing forests; and

(*d*) Land utilisation and co-ordination.

Other connected subjects such as irrigation and drainage, crop production, grasslands and pastures, industrial utilisation of agricultural and forest produce and marketing of produce from the land, should be dealt with in consultation and co-operation with corresponding organisations.

Among the functions of this Board will be:

(*i*) Preparation of soil maps of India after necessary surveys;

(*ii*) Correlation of results of manurial and varietal trials in selected areas with types of soils, agricultural practice and land reclamation; and

(*iii*) A complete erosion survey.

7. The whole area in a province or a state should be divided into physiographic units, each having a co-ordinated programme of soil conservation suited for its special needs. The programme to be followed should be based on thorough investigation and research in typical localities.

8. There should be a central institute for the study of soil problems, and especially those of erosion,

9. There should be provision for a fully equipped research station in each of the different soil areas for soil and silvicultural research and developmental utilisation.

10. Adequate facilities should be provided for training in forestry and agriculture in the universities and technical institutes, especially with a view to making the results available to the public.

11. One of the most striking features of the present utilisation of the total available area is the small proportion devoted to village or minor forests, grasses, legumes and other soil-conserving crops, pastures, fruit and other trees, to meet the needs of the rural communities for food, fodder, fuel, timber, etc. A policy of well-distributed afforestation, especially with reference to village or minor forests, should be pursued by the state, in particular with regard to those lands which have been thrown out of cultivation or which are at present regarded as culturable waste and can be reclaimed.

12. Soil Erosion.—

(*i*) Shifting cultivation must be controlled or eliminated, as also breaking of virgin forest lands. Contour ridging, terracing and levelling of fields and other measures required for the control of erosion should be encouraged by means of remission of land revenue, education and propaganda.

(*ii*) Co-operative activities should be enlarged to include land reclamation, village afforestation and forest management.

(*iii*) Afforestation work should be extended in the plains with a view to provide (*a*) shelter belts, (*b*) fodder trees, (*c*) hedgerow timber and (*d*) fuel supply.

13. *Reclamation.*—Vast stretches of saline and alkaline soils, sand deposits, arid and semi-arid soils, swamps and other types of water-logged soils, ravines and soils afflicted by defects not covered by the above, are known to exist in the country. It is necessary in the first place to provisionally classify these soils according to their more obvious characteristics and to obtain a broad idea of their

extent of occurrence. This should form part of the survey programme. Projects of reclamation should be based on careful research in which all scientific aspects should be taken into consideration.

14. *Soil Moisture.*—Improvements in agriculture and soils should be made through the regulation of water-supply, conservation of soil moisture and drainage and all necessary information for this should be gathered through the surveys contemplated. The extent and causes of water-logging and remedial measures should be studied in detail.

15. *Soil Fertility.*—Agriculture should be so planned as to maintain soil fertility at its optimum level. The suggestions made by the sub-committee in this behalf deserve consideration, more particularly those dealing with the conservation of organic matter and the cheapening of fertilisers.

16. *Forests.*—Forests must be preserved as a national heritage and forestry should be judged by the long-term financial results rather than the immediate surplus.

17. The following measures are especially recommended for protecting and improving the forest wealth of the country.

(*i*) In Provinces or states where there is no special working plans branch, such a branch should be established, as working plans are the essence of forest management.

(*ii*) Control of grazing, control of fire, contour trenching and gully plugging.

The general position in privately-owned forests is unsatisfactory. Such forests should, therefore, be acquired by the state or strictly controlled by the state in the public interest.

18. Forests should be developed and worked with a view to produce the raw materials for the following, among other, industries:

(1) Timber, particularly teak.

(2) Paper, including newsprint, packing and wrapping papers, "kraft" papers, strawboards.

(3) Insulation boards and similar other materials.

(4) Rayon.

(5) Plywood and veneers.

(6) Matches and pencils.

(7) Machine and tool parts made of wood.

(8) Lac for gramophone records, electrical insulation and plastics.

(9) Resins and varnishes.

(10) Essential oils.

(11) Tanning materials.

(12) Medicinal plants.

(13) Wood and charcoal to produce gas for internal combustion engines.

(14) Dyes.

19. Forest cottage industries should be encouraged and the possibilities for these should be investigated (e.g., rope-making, baskets, wicker-work, toys, etc.).

20. *Capacity of Forest to furnish Employment.*—The Census Returns of 1931 show that directly or indirectly the forests offer employment to about 2,000,000 people in British India alone. With more efficient utilisation of forest resources, it should be possible to find employment for a much larger number.

21. *Wild Life Sanctuaries.*—This Committee considers that organised large-scale hunts, with the help of hundreds of beaters, are not only inhuman, but are leading to the extinction of valuable wild life in the jungles and should be disallowed. For the protection and preservation of wild life in the jungles, national parks and sanctuaries should be established in various parts of the country.

22. *Communications.*—Out of the total area of 125,000 square miles of state forests, 54,000 square miles, that is, 43 per cent., are either inaccessible or profitless. It is urgently necessary to provide suitable means of communications, rail and rope-ways, roads, waterways and paths, as otherwise a fuller development of our forest resources will not be possible. Freight rates on forest produce are generally too high and should be reduced.

23. *Fires.*—Effective measures should be taken to minimise damage from forest fires, and for this purpose a Fire Protection Section of the Forest Department is recommended.

REVIEWS AND ABSTRACTS

EROSIONAL TOPOGRAPHY AND EROSION

By J. M. Little, E.M.

Published by Carlisle & Co., San Francisco, March, 1940.

The author has done a useful service in publishing this short treatise on the mathematical treatment of flood and erosion problems and the appearance of this book shows how steadily the practical knowledge of this subject has progressed since Wang's theoretical presentation of torrential water forces was first published from Vienna forty years ago. Little's calculations show the amount of water which can be expected from any given catchment for which engineers have previously used the well-known Kutter's formula. Little has developed a more logical attack on this problem by basing his formulæ on the known hydraulic processes of:

(*a*) Laminar flow for slowly moving water;

(*b*) Turbulent flow which occurs at ordinary river velocities; and

(*c*) Shooting or plunging flow, which occurs in gully formation and even in large rivers when in full flood.

Most of the author's tables such as his series for surface runoff for various combinations of slope, distance from summit, time of concentration, etc., are based upon the known experimental data of sheet erosion velocities, but he points out that little is yet known about the third type of flow (shooting or plunging), and this appears to be the next hurdle which hydraulics as a science must jump.

The author also deals effectively with the correlation of rainfall to runoff and with the influence of vegetative cover upon the rate of flow, points which have always bothered canal engineers and other water users when using Kutter's formula. Incidentally it is interesting to find mention of the work of Gerald Lacey, a well-known Indian canal engineer who has been a pioneer on the mathematical treatment of silt-laden streams and similar irrigation problems.

R. MACLAGAN GORRIE.

EXTRACTS

TACKLING THE SOIL EROSION PROBLEM

By Dr. R. Maclagan Gorrie

NEW TECHNIQUE IN HOSHIARPUR DISTRICT

Many words and much photographic film have been spent on describing the evils of soil erosion throughout the world, but what can be done about it? That is the question most people ask as soon as they have grasped the horrible potentialities of this state of affairs. Until recently we had to depend on photos from abroad to show what can be done, but at last India has got something to show. In the Hoshiarpur District of the Punjab, steps are now being taken to establish a series of demonstration areas. These are situated in the foothills of the Siwaliks where the erosion evil is seen at its worst. The object of these demonstrations is to teach the villager how to deal with sheet erosion and gullies when they cut into and spoil his own fields, and how to reclaim the raw loose sand of the local torrent beds and bring these back into productiveness.

Erosion has become a menace to the zamindar because the ordinary provisions of Nature to preserve a balanced régime have been flouted and destroyed. Steep hillsides once smothered in grass or jungle have been made into fields and the remaining jungle has been destroyed by goats and cattle. The essential first steps in stopping the rot must therefore be the proper terracing of all fields and the restoration of jungle conditions on all waste land. Where hundreds of square miles of foothill country have already been devastated, this is a tall order, but we have to make a start somewhere, even on a

small scale, to show that it is not only humanly possible but a feasible and commercially sound undertaking.

The "Cure."—First of all, get rid of the goat, that arch destroyer. In other countries where they are stall-fed and properly looked after, goats are valuable milking machines. Here they are "the machine-guns of the forests," as one of my forest rangers aptly names them, so they must go. Next, how to re-establish the lost forest cover? If given time, Nature will herself do the job but she does it slowly. To hurry matters up the recipe is "contour-trenching" and "gully plugging" in about equal proportions. The less precipitous slopes of the village waste are marked out in a system of trenches, each section of which must be kept dead level along the contour, so as to catch the maximum of water. In average hill-side conditions a trench 10 feet long and $1\frac{1}{2}$ feet broad and deep, sloped up to a much wider top width, costs 2 annas and will hold about a ton (or 25 gallons) of rain-water. Many will of course breach in the first heavy storm and many will silt up with the soil washed into them, but the net effect over a catchment area of about 200 acres was to prevent any flooding in the stream bed, while an untreated *nala* nearby was flooding briskly with $2\frac{1}{2}$ inches rainfall which fell equally in both.

An integral part of this new technique of storm trapping is to plug all the gullies and deep narrow *nala* branches with a series of small check-dams. These are made of stone where this is locally available: failing this of brushwood held down by stakes, or a mixture of poles and brushwood or bushwood anchored by stones; anything in fact that can be had on or near the spot. The main object of this "gully-plugging" is not to make a permanent engineering feature, but to delay the silt-laden flood and hold back part of its load of detritus and soil wash until plant growth can fix it firmly. As soon as a foot or so depth of soil has been trapped the vicinity of the checkdam is planted up with anything which will take root quickly. The favourite plant varies from place to place even in one district, for in the Sohan valley in Una we use *japlota* and *tohr* (prickly pear): in the stony gullies we use *keora* (Agave) and in the damper *nalas* we can use *baint* (willow) and bamboo, while in the wider sandy torrent bed we use *nara* reed and *banha*, which last is our best standby. The freshly broken soil on the trench berm will soon fill

up naturally with local grasses but we prefer to hasten the process and secure a good paying crop for the owner of the land by planting *bhabbar* grass which sells at 10 annas a maund on the hillside and goes to the nearest paper mill to be made into paper.

If this work is done in the head of each small *nala* branch where we can deal with the "little waters," the effect must be of course that a large percentage of even the heaviest storms sinks into the subsoil, emerging weeks later in rejuvenated springs, and helping to establish a stable level in the wells, which in the district have developed a horrible habit of shrinking, if not drying up entirely.

Difficulties.—When the "big waters" emerge from the confines of the hills they tend to splay out over a wider bed, and if much sand is being brought down the torrent forms a fanshaped cone of deposition spreading sterile sand in an ever widening arc of destruction, burying fields and ruining the countryside. Here a different technique is required, for one cannot force a big torrent into obedience. It has to be humoured and wheedled rather than bullied up massive dams and obstructions. Here the *banha* bush (Vitex negundo) comes into its own, for a trench of partly buried branches will take root miraculously and form a live hedge in a few months. If a series of such hedges is put at a slight angle to the force of the torrent, they will act as tooth-combs to rob the torrent of some of its force and of its silt which is deposited between and behind the hedges. The next step is to consolidate these newly made terraces and this is done by planting *sirkana* grass in the shade of which *shisham*-tree seed is later sown.

The most pleasing feature of these demonstrations is the real interest they are arousing in the local Rajputs and their tenants. The very idea that their ruined hillsides can again be made productive is putting fresh heart into many of them who have during the last few years of increasingly hard times lost courage and "got their tails between their legs." Now every man in the village can improve his fields and earn more from the wasteland as well and the lazy ones will perhaps be coerced into doing their share by the co-operative societies which are being formed to put this land reclamation work on an organized basis of self-help.—*The Sunday Statesman, September* 10, 1939.

A MEETING WITH FRIENDLY TREES

BY SIMON EVANS

"O dreamy, gloomy, friendly trees,
I came along your narrow track,
To bring my gifts unto your knees,
And gifts did you give back."

In this machine age, there are few men who walk a score of miles a day. When such a walk becomes a habit, as it does with shepherds, gamekeepers and country postmen, and when the walker strides out over the same stretch of countryside every day, trees become important landmarks.

"Jus' keep them eyes o' yourn peepin' about you, when you'm walkin' through the blackthorn an' the ash yonder. I've a couple o' moidering, freckled-faced ewes as 'ull keep wandering." These were the parting words of old Dick Broome, the shepherd, when I left him a few mornings ago.

"Take the path beneath the chestnuts," I advised the leader of a party of ramblers, "and make for the lower edge of a clump of beech trees; then look down-hill for three tall fir trees. They're near the cross-road, and you'll find a signpost there."

Thus do countrymen talk.

On my daily walk, which begins at seven o'clock in the morning and ends at five o'clock in the afternoon, I have little more than one mile of hard highway on which to travel. This, if I were asked the way of it, would be my answer: "Turn from the High Street where the weeping willow grows; and, at the foot of the steep hill, turn again into the field where the pear trees stand high, and keep near the hedge. Then over the stile into a green ferny lane; take the path beside the hedge in which the blackthorn grow; then on and up a steep bank where young damson trees grow in line; over a boggy, low-lying meadow to a line of beech trees above a narrow dingle; and on to a gap in the distant hedge, near a solitary pine tree, then down into a long deep dale. Walk due north for a while and, under the branches of a giant beech tree, cross the brook by a narrow footbridge, follow the brook and pass through an orchard which almost hides a black and white farmhouse; then over the bridge by the sally trees and up to a spinney of larch where Gipsy Locke has his camp. . . ."

That covers the first three miles or so of my morning walk. I wonder, in these days of speeding tourists, fast traffic and mystery trips, how many men would find it easy to follow the above directions. "But the places you have mentioned have no real names; they are not on the map," they may say. That is true for them, but not for me, because I have myself given names to many of the trees in the Valley of the Rea and on the slopes of Clee Hill.

John and Mary are a pair of old oaks which stand close together, almost arm in arm it seems, on the first ridge of high ground above the Rea. Seen against the sky, when the light is not too bright, they have some resemblance to a head-and-shoulder view of an old couple. In spite of their years, they hold their heads high, she with an old-fashioned bonnet and a few stray locks of hair above her forehead, and he with a battered, almost rimless, billycock hat pulled well down over his eyes.

My Autumn Flames are a group of chestnuts. In the autumn, against the greenest of green backgrounds, they are a picture I cannot pass; always I must stand and stare and wonder for a few moments. Can any artist hope to paint such a scene? Why is this banky field so very green? And why are these trees more vivid, more flame-like, than any others in the Valley? I cannot tell.

And Talking Tom! Who is he? He is an aspen, standing at the end of a lonely little lane which leads to the open common. He seems to be always talking and whispering—his stalks being so long and slender that he is shaken by the slightest breeze. Sometimes he whispers quietly, as if to himself alone; sometimes his speech is loud and hurried, as if he has a score or more secrets to tell me.

Poplars are scarce in the Valley of the Rea and on the slopes of Clee, but on the Corve Dale side of Brown Clee there are a few poplars standing in a line. I call them "The Strangers," because they always remind me of foreigners walking in single file through a country where they can see no others of their own kind. When I pass near them, they seem very tall and dignified; and, when I leave them behind to climb the steep fields on the middle slopes of Clee, I feel myself to be taller than I am. Then I cannot but whisper:

"To-day I have grown taller from walking with the trees.
The seven sister poplars that go softly in a line."

I often see timber-fellers at work, but—although I know their work is work which, for good reasons, must be done—I do not like to stand and look at grand old giants of the country fallen to the ground. Many of them, more often than I can remember, have sheltered me from storms and shielded me from the sun. They have made music for my ears; fir trees in Guady Dingle, where I often sit and rest, are mighty harps for the southwest winds; beech and oak are full of deep brave notes, while in a larch plantation there is a soft, whispering, rushing music in the air that sets my feet dancing. Walking alone, as I do every day, I find that trees become more and more friendly. How easy, at night beneath the stars, to imagine the trees whispering and talking together!

I like a wooded countryside and I think Shropshire, of all the English counties, has the biggest and finest trees. How bare and cold is a hillside that has been stripped of its trees! How warm and rich are the "valleys of springs of rivers, by Ony and Teme and Clun," and how beautiful are the wooded slopes of Shropshire's dales—Corve Dale, Hope Dale and the little dales which shall be nameless!

I know tracks too narrow for motor-cars, too rough for bicycles. There is good reward for men who walk. They can wander in the little dales among the "dreamy, gloomy friendly trees" and listen to their music. I am always pleased when I meet old Farmer Shakeshaft, who is so slow and wise. If it is at all possible, he commemorates every little and big event by planting a tree.

"Who does his duty is a question
Too complex to be solved by me,
But he—I venture the suggestion—
Does part of his that plants a tree."

NEW STUDIES IN DURABILITY OF WOOD

Scientific investigation in the last half century has undoubtedly advanced the standardising of methods of production and materials. The determination of the properties of structural materials and the introduction of new units of measurement have enabled physical and mechanical properties to be expressed numerically, so that it is possible to compare one material with another simply and quickly.

There are some properties, however, for the measurement of which no standard unit has yet been devised and all that has been possible is to compare on an empirical basis one material with another. As pointed out in the English journal, *Wood*, one of the important properties of timber which falls into this class is durability and in this case the fact that the term has never been satisfactorily defined opens the way to even wider confusion, so that quite commonly the word is used in the different senses of hardness, resistance to wear and resistance to decay.

In early times when wood, stone and a very limited number of metals were used, there was some justification for associating hard-wearing qualities with hardness. As applied to timber, however, hardness, as such, cannot be regarded as an unfailing guide to resistance to wear. If all timber were of like structure, then, indeed, this might be safely assumed, but experience has shown that in wood, with varying amounts of hard and soft tissue arranged in many different ways, hardness as generally measured by resistance to indentation is not always synonymous with resistance to hard wear.

The use of the word "durability" to mean resistance to decay is widespread, but there is no direct connection between the hardness and wear-resisting properties of any particular wood on the one hand and its ability to withstand the attacks of decay on the other. In the first place, resistance to decay depends as much on extraneous conditions as on any inherent quality of the wood, so that almost any kind of timber will remain sound in one set of circumstances, while the most resistant wood cannot be relied upon to remain free from decay indefinitely in another.

The fungi, which are the direct cause of rot in wood, are plants which need moisture for germination and growth and are only capable of activity when they are not subjected to very high or very low temperatures. Unfortunately, climatic conditions over a large part of the earth's surface, excluding polar and torrid desert areas, are fairly suitable for fungal growth, so that only the more resistant timbers can be relied upon to remain reasonably sound for any length of time, unless they are given a preservative treatment. Obviously, through seasoning of timber before use, to get rid of

surplus moisture, is the first step in the prevention of rot. If the timber is subsequently employed in situations where it is unable to re-absorb water, the risk of decay developing, no matter what kind of timber it is, is negligible. Again, if used under conditions excluding air as, for instance, entirely submerged in non-tidal water or deeply buried in wet earth, any timber is likely to remain sound for many years. As to the inherent power of resistance arising from some constituent of the wood itself, some timbers are much superior to others, but it is equally certain that hardness is not to be relied upon as an indication of power of withstanding decay.

In view of all this well-founded evidence, it is quite clear that hardness, hard-wearing qualities and resistance to decay are not inter-related and that to use the term "durability" indiscriminately in connection with all of them is likely to lead to confusion.

There has been an almost complete change-back to the wooden sleeper in nearly all railway systems in Central, Northern and Western Europe. As is well-known, the metal sleeper had supplanted the wood sleeper in several countries for many years. There has been considerable discussion and argument as to which is the cheaper material in the long run. On the basis of many years' experience and exhaustive tests, the wooden sleeper has emerged as the victor in this competition. The metal sleeper has proved to be much more expensive for its life in service than the treated wooden sleeper. Near chemical plants and large bodies of water there is very serious corrosion with metal sleepers. Furthermore, the metal sleeper rattles and causes undue vibration and noise and does not enjoy the resilience supplied by the wooden sleeper.—*Wood Products*, dated July, 1940.